

NOTE

This Microfiche meets the quality requirements of the American National Standard for Microfiche of Documents (ANSI PH5.9-1975). However, because of imperfections in the document from which it was made, it contains images that are illegible or difficult to read. The source document for this microfiche is the best copy that could be obtained prior to filming.

ENVIRONMENTAL HEALTH IN THE 21ST CENTURY

HEARING

BEFORE THE

SUBCOMMITTEE ON NATURAL RESOURCES,
AGRICULTURE RESEARCH AND ENVIRONMENT

OF THE

COMMITTEE ON
SCIENCE, SPACE, AND TECHNOLOGY
U.S. HOUSE OF REPRESENTATIVES

ONE HUNDREDTH CONGRESS

SECOND SESSION

APRIL 6, 1988

[No. 123]

Printed for the use of the
Committee on Science, Space, and Technology



U.S. GOVERNMENT PRINTING OFFICE

WASHINGTON : 1988

88-924

For sale by the Superintendent of Documents, Congressional Sales Office
U.S. Government Printing Office, Washington, DC 20402

H701-13

COMMITTEE ON SCIENCE, SPACE, AND TECHNOLOGY

ROBERT A. ROE, New Jersey, *Chairman*

GEORGE E. BROWN, Jr., California
JAMES H. SCHEUER, New York
MARILYN LLOYD, Tennessee
DOUG WALGREN, Pennsylvania
DAN GLICKMAN, Kansas
HAROLD L. VOLKMER, Missouri
BILL NELSON, Florida
RALPH M. HALL, Texas
DAVE McCURDY, Oklahoma
NORMAN Y. MINETA, California
BUDDY MacKAY, Florida
TIM VALENTINE, North Carolina
ROBERT G. TORRICELLI, New Jersey
RICK BOUCHER, Virginia
TERRY L. BRUCE, Illinois
RICHARD H. STALLINGS, Idaho
JAMES A. TRAFICANT, Jr., Ohio
JIM CHAPMAN, Texas
LEE H. HAMILTON, Indiana
HENRY J. NOWAK, New York
CARL C. PERKINS, Kentucky
C. THOMAS McMILLEN, Maryland
DAVID E. PRICE, North Carolina
DAVID R. NAGLE, Iowa
JIMMY HAYES, Louisiana
DAVID E. SKAGGS, Colorado
PAUL E. KANJORSKI, Pennsylvania
GEORGE J. HOCHBRUECKNER, New York

MANUEL LUJAN, Jr., New Mexico *
ROBERT S. WALKER, Pennsylvania
F. JAMES SENSENBRENNER, Jr.,
Wisconsin
CLAUDINE SCHNEIDER, Rhode Island
SHERWOOD L. BOEHLERT, New York
TOM LEWIS, Florida
DON RITTER, Pennsylvania
SID MORRISON, Washington
RON PACKARD, California
ROBERT C. SMITH, New Hampshire
PAUL B. HENRY, Michigan
HARRIS W. FAWELL, Illinois
D. FRENCH SLAUGHTER, Jr., Virginia
LAMAR SMITH, Texas
ERNEST L. KONNYU, California
JACK BUECHNER, Missouri
JOEL HEFLEY, Colorado
CONSTANCE A. MORELLA, Maryland
CHRISTOPHER SHAYS, Connecticut

HAROLD P. HANSON, *Executive Director*
ROBERT C. KETCHAM, *General Counsel*
CAROLYN C. GREENFELD, *Chief Clerk*
R. THOMAS WEIMER, *Republican Staff Director*

SUBCOMMITTEE ON NATURAL RESOURCES, AGRICULTURE RESEARCH AND ENVIRONMENT

JAMES H. SCHEUER, New York, *Chairman*

TIM VALENTINE, North Carolina
DAVE McCURDY, New York
HENRY J. NOWAK, New York
C. THOMAS McMILLEN, Maryland
GEORGE E. BROWN, Jr., California
GEORGE J. HOCKBREUCKNER, New York

CLAUDINE SCHNEIDER, Rhode Island
ROBERT C. SMITH, New Hampshire
PAUL B. HENRY, Michigan
JOEL HEFLEY, Colorado

* Ranking Republican Member.

CONTENTS

WITNESSES

April 6, 1988:	Page
Dr. David P. Rall, director, National Institute of Environmental Health Sciences	5
Dr. Sanford A. Miller, University of Texas—San Antonio	13
Dr. Robert A. Goyer, University of Western Ontario	33
Dr. Ellen K. Silbergeld, Environmental Defense Fund.....	41
Dr. Ken Sexton, Director, Office of Health Research, U.S. Environmental Protection Agency	63
Gershon W. Fishbein, Environmental Health Letter.....	72
Dr. Bernard Goldstein, UMDMJ—Robert Wood Johnson Medical School, Department of Environmental and Community Medicine.....	77
APPENDIX—Additional material for the record.....	101

ENVIRONMENTAL HEALTH IN THE 21ST CENTURY

WEDNESDAY, APRIL 6, 1988

HOUSE OF REPRESENTATIVES, COMMITTEE ON SCIENCE,
SPACE AND TECHNOLOGY, SUBCOMMITTEE ON NATURAL
RESOURCES, AGRICULTURE RESEARCH AND ENVIRON-
MENT,

Research Triangle Park, NC.

The subcommittee met, pursuant to notice, at 2 p.m., in conference room A, National Institute of Environmental Health Sciences, Research Triangle Park, NC, Hon. Tim Valentine (chairman of the subcommittee) presiding.

Mr. VALENTINE. The subcommittee will please be in order.

We appreciate the attendance of the ladies and gentlemen of this panel. We appreciate you all taking the time to come and be with us here for this hearing following your symposium, and we will proceed as expeditiously as possible because I understand that some Tennessee weather is coming in. We do not usually have anything that is as disturbing like hail and high winds and that sort of thing, but I understand that is on the way, and it is none of our doing, but we will get to you.

I have a few sentences, few paragraphs, to put in here.

I am pleased that the Subcommittee on Natural Resources, Agriculture Research and Environment is here in the Second Congressional District today to hold a field hearing on emerging environmental health issues in the 21st Century.

I am also pleased that my colleague and good friend from the Fourth Congressional District, which of course adjoins us here, Representative David Price, is with us this afternoon. We both serve on the House Science, Space and Technology Committee.

And on behalf of the Science Committee and myself, I would like to express our gratitude to Dr. David Rall for allowing the Subcommittee to use the facilities of the NIEHS once again. We appreciate all you have done, Doctor, to accommodate us for this hearing as well as other Committee proceedings in the past.

I believe the Subcommittee made a wise choice in holding a hearing at the conclusion of this symposium. The Subcommittee has jurisdiction in a number of environmental areas, and the symposium offers us the unique opportunity to take advantage of the work of NIEHS, the work that NIEHS has accomplished in assembling a distinguished group of experts in the area of emerging and future trends in environmental health issues.

The purpose of this hearing is to take a closer look at the important emerging and future trends in environmental health. As our ability improves to understand the connection between health and exposure to low levels of toxic chemicals and radiation in our indoor and outdoor environments and in our water and food supplies, we must find ways to decrease the potential danger to the public.

In recent years, substantial gains have been made in controlling traditional pollutants in air and water. In the area of air pollution, ambient concentrations of particles declined by 20 percent; sulfur dioxide by 36 percent; and lead by 67 percent. In water, pollutant discharges from municipal plants have decreased by 46 percent and pesticides with adverse and persistent environmental effects have been removed from the market. Despite these gains, other environmental health concerns are emerging that will present more technologically difficult and expensive problems, and complex legislative challenges.

In examining this issue, I think we all can agree on three points. First, improvements in analytical techniques now permit scientists to measure extremely small concentrations of chemicals in the environment, frequently down to the part per trillion level. Also, medical technology and science has been improving its ability to measure subtle health effects.

Second, as our nation moves more toward increased dependence on microwaves, computers, superconductors and other non-ionizing radiation, so will opportunities increase for greater exposure to potentially harmful low-level toxic substances. These new trends may raise the level of public concern about very low concentrations of toxic chemicals found in food, drinking water, soil and indoor and outdoor air.

Third, as medical science improves its abilities to measure subtle effects and to link such effects to chronic exposures of low levels of toxins in the environment, and as new techniques are developed to measure small concentrations of chemicals, it is possible that we will recognize a new, broad range of environmentally-caused illnesses from which the public will demand new protections.

Is our existing environmental health research program adequate to anticipate and address emerging environmental effects? Testimony at the hearing will assist the Subcommittee in determining the adequacy of current levels and directions of the federal environmental research programs under the jurisdiction of the Subcommittee.

We are examining a critically important public health question and look forward to hearing from each of the witnesses today.

[The prepared opening statement of Mr. Valentine follows:]



NEWS

from the office of

CONGRESSMAN TIM VALENTINE

2nd District, North Carolina

DURHAM • (919) 541-5201

ROCKY MOUNT • (919) 446-1147

WASHINGTON, D.C. • (202) 225-4531

FOR IMMEDIATE RELEASE
APRIL 6, 1988

FOR MORE INFORMATION CONTACT
ROGER STRICKLAND (202)225-4531

STATEMENT OF THE
HONORABLE TIM VALENTINE
BEFORE THE
SUBCOMMITTEE ON NATURAL RESOURCES,
AGRICULTURE RESEARCH AND ENVIRONMENT
"ENVIRONMENTAL HEALTH IN THE TWENTY-FIRST CENTURY"
NATIONAL INSTITUTE ON ENVIRONMENTAL HEALTH SCIENCES
RESEARCH TRIANGLE PARK, NORTH CAROLINA
APRIL 6, 1988

I am pleased that the Subcommittee on Natural Resources, Agriculture Research and Environment is here in the Second Congressional District today to hold a field hearing on emerging environmental health issues in the Twenty-first Century.

I am also pleased that my colleague and good friend from the Fourth Congressional District, Representative David Price, is here with us this afternoon. We both serve on the House Science, Space, and Technology Committee.

And, on behalf of the Science Committee and myself, I would like to express our gratitude to Dr. David Rall for allowing the Subcommittee to use the facilities of NIEHS once again. We appreciate all you have done to accommodate us for this hearing as well for other Committee proceedings in the past.

I believe the Subcommittee made a wise choice in holding a hearing at the conclusion of this symposium. The Subcommittee has jurisdiction in a number of environmental areas, and the symposium offers us the unique opportunity to take advantage of the work NIEHS has accomplished in assembling a distinguished group of experts in the area of emerging and future trends in environmental health issues.

The purpose of this hearing is to take a closer look at important emerging and future trends in environmental health. As our ability improves to understand the connection between health and exposure to low levels of toxic chemicals and radiation in our indoor and outdoor environments and in our water and food supplies, we must find ways to decrease the potential danger to the public.

In recent years, substantial gains have been made in controlling traditional pollutants in air and water. In the area of air pollution, ambient concentrations of particles declined by 20 percent; sulfur dioxide by 36 percent; and lead by 67 percent. In water, pollutant discharges from municipal plants have decreased by 46 percent, and pesticides with adverse and persistent environmental effects have been removed from the market. Despite these gains, other environmental health concerns are emerging that will present both technologically difficult and expensive problems, and complex legislative challenges.

-MORE-

In examining this issue, I think we all can agree on three points. First, improvements in analytical techniques now permit scientists to measure extremely small concentrations of chemicals in the environment, frequently down to the part per trillion level. Also, medical technology and science has been improving its ability to measure subtle health effects.

Second, as our nation moves more towards increased dependence on microwaves, computers, superconductors, and other non-ionizing radiation, so will opportunities increase for greater exposure to potentially harmful low-level toxic substances. These new trends may raise the level of public concern about very low concentrations of toxic chemicals found in food, drinking water, soil and indoor and outdoor air.

Third, as medical science improves its abilities to measure subtle effects and to link such effects to chronic exposures of low levels of toxins in the environment, and as new techniques are developed to measure small concentrations of chemicals, it is possible that we will recognize a new, broad range of environmentally-caused illnesses from which the public will demand new protections.

Is our existing environmental health research program adequate to anticipate and address emerging environmental effects? Testimony at the hearing will assist the Subcommittee in determining the adequacy of current levels and directions of the federal environmental research programs under the jurisdiction of the Subcommittee.

We are examining a critically important public health question and look forward to hearing from each of the witnesses today.

-END-

Mr. VALENTINE. I am happy to recognize at this time my colleague who has been previously introduced to you, a distinguished member of Congress and my good friend, David Price.

Mr. PRICE. Thank you, Mr. Chairman.

I want to commend you for your leadership in convening this hearing today, and thank you for inviting me. Although I am not a member of this particular Subcommittee, I am a member of the full Committee on Science, Space and Technology, and I appreciate very much the chance to join you for these hearings today.

I also want to add my thanks to NIEHS for their gracious hospitality for hosting us today and to Dr. Rall and all these witnesses for accommodating the Subcommittee's schedule. We are taking advantage of a very fine symposium which NIEHS has held these last two days. We are building on that in these hearings today and taking advantage of these distinguished witnesses being here. We are grateful for their accommodating us and look forward to their testimony.

This is a unique opportunity for us as members of the Science Committee to take a longer range view of our environmental health problems, some of the emerging problems that we may be facing, some of the problems that we are going to be considering as we look toward the 21st Century. So I welcome the chance to take this long-range view and appreciate your leadership in arranging these hearings today.

Mr. VALENTINE. Thank you, David.

Our witness list today includes David Rall, Director, National Institute of Environmental Health Sciences; Dr. Robert Goyer, University of Western Ontario; Dr. Ellen Silbergeld, Environmental Defense Fund; Mr. Ken Sexton, Director of Health Research, U.S. Environmental Protection Agency; Dr. Sanford Miller, University of Texas-San Antonio; Mr. Gershon Fishbein, Environmental Health Letter and Dr. Bernard Goldstein, UMDNJ-Robert Wood Johnson Medical Center, Department of Environmental Health and Community Medicine.

Dr. Rall.

STATEMENT OF DR. DAVID P. RALL, DIRECTOR, NATIONAL INSTITUTE OF ENVIRONMENTAL HEALTH SCIENCES

Dr. RALL. Thank you very much, Mr. Chairman. It is a pleasure to welcome you and Mr. Price back to the National Institute for Environmental Health Sciences here in our main facility.

As you all know, we have just completed a Conference on Environmental Health in the 21st Century during which we attempted to look forward and try to take some estimate of what health problems may occur in the next 10, 15 or 20 years.

These exercises can be useful in suggesting priorities to us for basic research studies that will provide the scientific knowledge necessary if these technologies come into place and there are related problems. During the Conference we also looked at the future; a future that to us looks very exciting. There are technological advances that we can predict rationally, not just as a matter of wishful thinking, that will greatly improve the quality of life in the next century.

But we also know from past experience that there have been few great discoveries that did not bring with them some less than desirable side effects. Our view is that scientists have a responsibility to look into the future, to see the changes ahead, anticipate the side effects of these changes and alert leaders in public policy to try to prevent or minimize such negative side effects.

We had no crystal ball, we attempted a rational approach. Was our effort realistic? Could we look into the future with a degree of accuracy sufficient to make this conference worthwhile? History tells us that scientists do not always do so well when they try prognostication. The astrophysicist, Simon Newcomb, the first American honored with a place in the French Academy of Sciences after Ben Franklin, argued against the proposition that humans would ever be able to build a useful flying machine in 1901, 1902 and 1903. I hope the lesson from Simon Newcomb's experience is not that we can never make meaningful predictions, but that we should be as realistic as we can be.

In setting the program for the conference we were selective in the topics to be discussed. We started with problems of detecting subtle effects of low level contaminants in the environment. Recent NIEHS and NIH sponsored research has shown that the effects of lead on children are much more severe at lower levels than was previously thought. The research on the effects of lead provides a model for future studies on the detection of subtle effects of exposure and uptake of other toxic substances. This is important for two reasons; one, because of the health implications of the lead itself; and second, because the experience with lead in the environment tells us how easy it is to overlook or ignore serious effects in large numbers of people because the cause and effect is not clearly obvious.

In other sessions we looked at food, food consumption habits and food production; fresh waters and the oceans; buildings and the indoor air; future work place environments and increases in exposure to non-ionizing radiation and electromagnetic fields.

There were at least two significant environmental issues we did not cover. The first, increased CO₂ levels, the greenhouse effect leading to global warming. Second, the stratospheric ozone depletion leading to increased UV exposure. We did this deliberately. These are very important issues, but they are well discussed in the scientific community and in the public policy arena and we focused our attention on issues which had not been so well discussed.

While we must maintain concern and vigilance about the first and second level effects of technological change and development, we must always remember that these changes are very beneficial.

Advances in molecular biology are already making it possible to do what we only dreamed of recently. We can clone DNA, produce to produce specific proteins and create monoclonal antibodies, a process that is revolutionizing medical treatment.

Efforts to map the human genome continue apace. We will soon have a vastly increased understanding of human variations in susceptibility to exposure to environmental agents. This will raise ethical questions which we must solve, the significance is enormous.

Growing knowledge about the function of proto-oncogenes and oncogenes will enhance our understanding of the origins of cancer

and will improve the ability to identify carcinogens in laboratory studies and to prevent, diagnose and treat cancer.

Today, you will hear from several speakers who were the stars of this conference. Mr. Chairman, we look forward to the future, it is a bright future, let us all work to insure it is a safe future.

Again, let me welcome you to NIEHS, and I would be happy to answer any questions you may have.

[The prepared statement of Dr. Rall follows:]

Statement of

David P. Rall, M.D., Ph.D, Director

National Institute of Environmental Health Sciences
National Institute of Health

before the

Subcommittee on Natural Resources, Agricultural Research,
and the Environment

Committee on Science, Space, and Technology

April 6, 1988

Mr. Chairman, it is a pleasure to welcome you and the members of the subcommittee to the National Institute of Environmental Health Sciences at our facility in the Research Triangle Park in North Carolina.

As you know we have just completed a Conference on Environmental Health in the 21st Century during which we heard about environmental health problems which may either emerge or become more serious within the next 10 to 15 years.

These kinds of exercises can be useful in suggesting priorities to us for basic research studies that provide the scientific knowledge necessary to prevent environmentally related illnesses.

During the conference we looked toward the future; a future that looks exciting. There are technological advances that we can predict rationally,

not just as a matter of wishful thinking, that will greatly improve the quality of life in the next century.

We can anticipate more accurate medical diagnoses and more effective and better targeted medical treatments. We can also expect to see more precise epidemiologic studies.

We may see cheaper and even storable electrical power from advances in superconducting devices; greater progress in the prevention of exposure to hazardous substances and resulting diseases; new modes of transportation and communication; and many other changes which will make our lives healthier and easier.

But we also know from past experiences that there have been few great discoveries that did not bring with them some less than desirable side effects. Scientists have a responsibility to attempt to look into the future, see the changes ahead, anticipate the side effects of these changes, and alert leaders in public policy to try to prevent or minimize any negative side effects.

We had no crystal ball, but we attempted a rational approach. Was our effort realistic? Could we look into the future with a degree of accuracy sufficient to make the conference worthwhile? Certainly there have been scientists whose predictions were less than on target. The astrophysicist, Simon Newcomb, the first American honored with a place in the French Academy of Sciences after Benjamin Franklin, argued against the proposition that

humans would ever be able to build a useful flying machine in 1901 and 1903. The lesson from Simon Newcomb's experience is not that we can never make meaningful predictions about the future. Rather, it cautions us to be sure that we are more realistic than he was.

In setting the program for the conference we were selective in the topics to be discussed. We started with the problem of detecting subtle effects of low levels of environmental exposures. Recent NIEHS and NIH sponsored research has shown that the subtle effects of lead on children are much more severe at much lower levels than was previously thought. The research on the effects of lead provides a model for future studies on the detection of subtle effects of exposure and uptake of other toxic substances. This is important both because of the health implications and because the experience with lead in the environment tells us how easy it is to overlook or ignore serious effects in large numbers of people because the cause and effect is not clearly obvious.

Other sessions looked into expected changes and effects in:

- o food, food consumption habits, and food production
- o fresh waters and the oceans
- o buildings and the indoor air

- o future work place environments (using the microelectronics industry as an example)
- o increases in exposure to non-ionizing radiation from electronic sources

There were at least two significant environmental issues not covered in the conference: increased CO₂ levels, the greenhouse effect leading to global warming and stratospheric ozone depletion leading to increased ultraviolet exposure. The omission of these problems and their possible effects on health should not be interpreted as complacency, but attests to the broad attention they are already receiving.

While we must maintain concern and vigilance about the first and second level effects of technologic development and change, we should also give attention to the discoveries and technology which will be available to deal with the problems.

- o Advances in molecular biology are already making it possible to do what we only dreamed of until recently. The ability to clone DNA to produce specific proteins and to create monoclonal antibodies is revolutionizing medical treatment.
- o Efforts to map the human genome continue apace. In the future we will have a greatly increased understanding of human variation in

susceptibility to exposure to environmental agents. While this will raise ethical questions about the application of the knowledge, the significance for the prevention of disease is tremendous.

- o Growing knowledge about the function on proto-oncogenes and oncogenes will enhance our understanding of the origins of cancer and will improve the ability to identify carcinogens in laboratory studies and to prevent, diagnose, and treat cancer.
- o Magnetic resonance and similar kinds of imaging will be used to examine the whole body and each of its component parts, allowing the gathering of specific information and improving diagnosis.

Today, the subcommittee will hear testimony from several speakers from the conference. Mr. Chairman, we all look forward to the future. It is a bright future. Let us all work to insure that it is a safe future.

Again I welcome you to the NIEHS and would be happy to answer any questions you may have.

Mr. VALENTINE. Thank you, Doctor.
Dr. Miller.

STATEMENT OF DR. SANFORD A. MILLER, UNIVERSITY OF
TEXAS-SAN ANTONIO

Dr. MILLER. Thank you, Mr. Chairman.

For the sake of the record, I think it will be useful if I introduce myself, particularly in view of the fact that my colleagues in Texas insist on proper identification since the University of Texas is a rather large institution. I am currently the Dean of the Graduate School of Biomedical Sciences at the University of Texas Health Science Center in San Antonio. That is quite different than the one in Austin—the University of Texas in Austin or any other place.

I also had the privilege of serving for nine years until July of last year as Director of the Center for Food Safety and Applied Nutrition at the Food and Drug Administration; and therefore, I have had some experience in attempting to deal with some of the regulatory issues associated with the changing nature of our food supply.

We often forget that food is an important part of the environment. Not only is it a contributor to environmental modification through the development of technologies used to grow, process and distribute food, but also food itself interacts within itself with the environment in terms of those interactions between the growing of food plants and animals and the environment. Food is also an important carrier of environmental contaminants, and it is probably that area that has again most attention in the environmental field.

I would like to discuss the issues of prediction of changes in three principal areas. First of all, I would like to briefly describe some of the predicted changes in the science and technology of growing and processing food. And then I would like to say a word or two about the possible impact of these changes on human health. Much of it is positive—some of it may cause us problems. Third, I would like to make a comment or two about the research necessary to prepare us to deal with these problems. Now being an academic and returning to being a true scientist again, I always have to finish with a research agenda. More research is always needed.

First of all, predicted changes. Over the past decade, there has occurred a profound change in the thinking of the American agricultural and food science researchers. Simply put, this has involved a switch from basically consideration of research to improve production of food, to one in which the quality of the product and its impact on human health has become the dominant themes. Moreover, this concern for health issues applies equally to the increasing attention being paid to the impact of new and old agricultural technologies on the environment.

For example, at the current time, there is significant research ongoing in the agricultural community to develop, using modern biological techniques, new strains of plants and animals having better and more optimum nutrient balances.

Other research is attempting to develop biological control of pests and integrate them with more effective and less persistent chemical controls. New resistant strains of plants and animals are

attempting to be developed, so-called indigenous protection technology, in which the organism itself would carry its own pesticide.

In the technology of farming, new minimal cultivation techniques are being developed, indeed are being put into effect, which involve minimum modification of fragile environments, particularly in marginal farmlands.

In food processing, equally dramatic changes are occurring. Indeed, I would argue that in food processing, there will occur I think a veritable revolution in the way foods are processed, distributed and sold.

For one thing, I think a whole new slew of technologies involved in the processing of food, such as food irradiation, will result in many cases in safer and certainly better quality foods. Perhaps more importantly, the development of combination technologies, along with such new technologies as irradiation, will produce even better products.

The continued automation and optimization of processes, indeed whole food plants, will result I think in a concentration of the industry which, while permitting greater control and perhaps more efficiency in food production, also will have problems which I will mention in just a moment.

The development of new encapsulation techniques will allow better control over the quality of food. New packaging materials, more complex ones that will maintain separate environments in the food package, so that the various components of the foods stay fresher and indeed safer. The development of chemical modification techniques on food ingredients to allow the development of practically any organoleptic format, will allow the fabrication of foods to specific requirements.

And finally in a list that can go on forever I think, there is a tendency toward increased use of so-called natural ingredients, a tendency which in my opinion I think is going to generate considerably more problems than they will resolve. And I will say a word about that too in a moment.

Overall, I think the result would be an increasing capacity to use a greater variety of raw materials and many of them never before used for human food, and at the same time paradoxically, a tendency to utilize a more limited number of basic commodities such as soybeans in the fabrication of new food products.

This all will result from the increasing capacity of technology to modify basic food structures, to construct literally any desirable organoleptic structure. It is well within technology today and I think will become much more so by the 21st Century, that we can really duplicate any food structure that is required.

The health impact of these changes are, I think, in some respects more difficult to predict. Obviously greater control of production and processing technologies offer real hope for reducing the burden on the environment resulting from traditional processing technologies. Waste water released from food plants has been a major problem very often in contamination of streams and groundwater, but using modern technologies, it may very well be possible to reduce that problem considerably at considerably lower expense.

Greater control of food structures allow construction of highly acceptable foods that have compositions that better meet the health

needs, particularly those concerned with degenerative diseases, as defined by contemporary nutrition science. We can literally change the fat concentration, the pattern of fats, the amount of carbohydrates, the trace elements and so in a structure that people will find very acceptable.

Nevertheless, as with all such exciting positive possibilities, there are potential counterbalancing problems of equal magnitude and I think Dr. Rall mentioned some of these a moment ago. For example, there exists for the first time, the possibility that the human dietary can be restricted to a relatively few basic materials, limiting traditional safety inherent in a variety of—in the variety of the traditional dietary. In addition, modern marketing techniques result in such rapid distribution of new products, that the need for safety and nutritional assurances before marketing is more imperative than ever. Pre-market approval will have to be extended to virtually any new technology. Once you release it to the environment, to the public, you no longer have control, it is out there.

Increasing knowledge has also made the level of biological function necessary for investigation of these new substances and technologies more detailed than ever thought of in the past. And finally, increased sophistication in processing has led us and will lead even more so in the future to the greater concentration of the industry, which results in larger and larger plants serving larger and larger populations, the result of which is that a single glitch in the process can affect literally most of the population of the United States in a very short period of time. The question arises, how do we deal with that.

This leads to a whole series of research areas and perhaps a very large research agenda. Many of these questions are going to have to be answered before I think we can truly enjoy the fruits of new technologies. I can assure you that the Food and Drug Administration will become increasingly conservative in the acceptance of new technologies as questions begin to arise in their own minds. And that does not serve the U.S. public well, nor does it result in the kinds of changes that we need to have take place, if we are to see the advantage of the future.

Certainly some of the areas that need to be worked on are common to all areas of toxicology. We need better and more sensitive toxicological methods, particularly those in the food area that test food as related to food additives. Traditionally we test food additives as some multiple of the maximum use in human food. You cannot do that with food, you cannot feed a hundredfold the concentration of 20% of the diet, it just cannot be done. And this has caused a great deal—and will cause more difficulties in the future.

New areas of adverse effects that may impair function rather than result in death, such as behavior, immune function and physical performance, will have to be looked at as well.

We will have to consider possible changes in the soil microflora as result from—resulting from the use of modified micro-organisms to protect plants and animals. We really do not know what will happen if these things take hold in the soil over long periods of time. We need to understand better how the relationships between these organisms might occur.

We need better to understand the relationship between diet and chronic diseases, so that more rational dietary construction can be made. We should not leave it to the market, we should leave it at least on the basis of new knowledge.

And we need to better understand the composition of food as we construct—as we concentrate and as we extract natural products to make so-called natural additives, it is possible and probable that substances that we never thought were of any problem because they are present in such low concentration, now become of significance and could result in serious health hazards.

And we need to better understand the relationship between diet and the xenobiotics of the environment. We simply do not understand what the dietary condition of individuals has to do with how well they respond to this huge number of substances which they are faced with every day.

And finally and most important, we need to educate our young people to carry on this research, to understand its implications, to make the appropriate recommendations and ultimately for some of them formulate the policies in these areas of human welfare. In other words, we have to begin thinking about educating integration of scientists rather than the minimalist scientists that we talked about and educated in the past.

Now this agenda of course is considerably more ambitious than any one agency can take care of. And clearly we need to continue and improve the integration among all the federal and state programs that are involved in the planning and support of research in this area. The NTP and the NIEHS have served this role well in the past. I think they need further support and their role in this area has to be expanded.

Mr. Chairman, I am willing and waiting to answer any questions you may have. Thank you.

[The prepared statement of Dr. Miller follows:]

EMERGING FOOD SAFETY ISSUES

by

Sanford A. Miller, Ph.D.
Director
Center for Food Safety and Applied Nutrition
Food and Drug Administration
Washington, D.C. 20204

and

Karen Skinner, Ph.D.
Special Assistant to the Director
for Science Policy
Center for Food Safety and Applied Nutrition
Food and Drug Administration
Washington, D.C. 20204

Presented at the University of Guelph Workshop on "Food Research 2000:
Challenges and Opportunities" held on the campus of the University of Guelph,
Guelph, Ontario, Canada on October 9, 1986

EMERGING FOOD SAFETY ISSUESINTRODUCTION

In asking me to talk about "Emerging Food Safety Issues" you certainly have challenged me with a formidable task. Topics that deal with the future and predictions of sorts always make me think of the ad in the New York paper which stated: "Due to unforeseen circumstances, no clairvoyant meeting tonight." And they also bring to mind the old saying: "Believing in fortune cookies leads to a crummy life;" nevertheless, I enjoy challenges and I address this subject with enthusiasm. More important, I believe the future holds wondrous things for us, but it will be magical or mysterious only if we fail to prepare ourselves now.

No one can say with certainty what lies ahead, but we do know that today's changes will determine tomorrow's issues. For this reason, I would like to talk about some of the major forces of change I see now developing, and the nature of issues growing out of them:

CHANGES

Broadly speaking, I believe the changes we are witnessing can be classified into three general groups: changes in production and distribution of food; changes in our understanding of health; and changes in socioeconomic status.

Changes in Production and Distribution of Food

First, let's turn to the changes in our ability to produce food. This conference is devoted to the question of future agricultural research, so I needn't spend too much time on the possibilities in this area. Still, we often get so engrossed in the elaborate details of individual developments that we lose sight of the tremendous impact broad changes in technology can have upon our lives -- of the profound influence technology can exert in the production and distribution of food.

Each of us is familiar with the much-heralded prospects for biotechnology -- for the potential to develop pest and drought-resistant plants; plants that produce their own fertilizer; more targeted chemical use; improved use of by-products; vaccines that stimulate the natural immunity of animals; and increased efficiency in animal and plant production and nutritional quality through gene insertion, advances in protein production, and embryo transfer. There are other technologies, however, which also can greatly affect the production and distribution of the world's food. Computer and electronic-based technologies, for example, may help farmers in livestock management. Animal identification, animal reproduction, and disease control and prevention are but three areas where this technology may play a role. In plant agriculture, information technology has application in pest management and irrigation control systems. With radar and other sensors, it also can facilitate the appropriate and efficient application of chemicals such as fertilizers, pesticides, and plant growth regulators, reducing the level of use, and thus decreasing hazard and cost. And, of course,

computer technology can hasten the exchange of information among scientists, producers, and consumers, as well as aid in the analysis of the increasingly complex models used to evaluate the impact of technology on society.

The impact of technology on food production is not confined solely to land. We are witnessing it in the skies and in the seas as well. Only in most recent times are we truly beginning to recognize the promise of satellite remote sensing from space. The views of the Chernobyl nuclear disaster brought the reality of satellite sensing into homes around the world. (And, parenthetically, I might add, it also brought home the fact the even technologies we don't normally associate with food concerns -- such as power plants -- can play a very real role in food safety issues.) Remote sensing can influence the way we think about and plan for farming by allowing, for example, assessment of crop conditions through analyses such as chlorophyll content of plants. Who obtains this information and how it is used could enormously influence land use, crop yields, and ultimately the nature of world diets and nutrition. Clearly, this technology has impact on not only economic and health, but also political and social issues.

In our waters, technology is playing a role through aquaculture. Estimates indicate that aquaculture accounts for about one-sixth of worldwide seafood consumption. Many envision opportunities for growth in this industry and substantial investments in "high tech" fish farming have been made in recent years. Certainly, science and technology will play a role in the integration of aquaculture and agriculture, and in applications to breeding, nutrition, disease control, and rearing practices of aquatic organisms. We already have rapidly growing

shellfish strains that mature in seven months rather than the traditional 18 months.

Clearly, changes in food technology and other systems which affect the food we eat hold the potential for making both great and subtle alterations in the very nature of the foods we eat and in the patterns and quantities with which we consume them. But food technology also may modify the foundation of our notions about what constitutes food and how it is processed. As these notions change, and novelty evolves into acceptability, it is possible we will face safety questions we never before needed to ask.

Our experiences with food irradiation foreshadow the potential for a constant barrage of new situations and new issues. In this case, we had to determine how to evaluate the safety of a food -- in its entirety -- rather than consider solely the possible effects of any individual trace chemicals which may have formed during irradiation.

Similarly, we will have to face new questions regarding the use of traditional foods in a non-traditional fashion; of products constructed from non-traditional raw materials such as fungi; and of fabricated foods composed of products of chemical synthesis. Indeed, the growing popularity of reduced calorie foods might be setting the stage for the appearance of foods which are non-nutritive in character -- foods which may taste and feel and have the the aroma of their traditional counterparts, but which have little or no nutritional value. The arrival of such foods could stimulate questions about their broader nutritional consequences and how they might affect dietary patterns. Our experiences some years ago with hydrolyzed protein diets have sensitized us to

the safety concerns which might be associated with situations such as extremely low calorie protein diets.

Finally, in talking about the changes affecting food production and distribution, we also must be cognizant of the developments occurring in processing, packaging, transporting, and marketing food. As our food industries become more concentrated and more automated, we must remain alert to new areas which may be critical to safety. Despite the fine record of our food industries, the potential for new problems remains constant, and indeed may be increasing. The dairy industry, for example, has relied primarily on two technologies, pasteurization and refrigeration, to protect the milk supply. Now, however, we are identifying outbreaks of listeriosis from dairy products and questions are emerging about the survival and viability of several different microorganisms under various temperature conditions. *Listeria* may be only the tip of the iceberg -- *yersinia*, *campylobacter*, *actinobacter*, pathogenic *E. coli*, and others are all appearing in our food supply and being associated with disease outbreaks that, in the past, were considered of unknown origin. To a significant extent, it has been the developments of contemporary technology -- gene probes, monoclonal antibodies, and so on -- that have permitted identification of these organisms.

Moreover, we see microbiological concerns gaining new attention as contemporary eating habits are influenced by factors such as fast food and widespread travel. New appreciation of microbiological safety is growing, for in our modern, mobile, mass production-oriented society a serious contamination can have far-reaching effects and tragic consequences. We saw this last year when more than 16,000 culture confirmed cases of illness from *Salmonella typhimurium* occurred in northern

Illinois and the surrounding states. The food vehicle was 2% low-fat milk produced by a dairy that supplied about 40% of the milk consumed in the Chicago area, a dairy described at the time as "state of the art." Certainly the need is apparent for modern food technologists, familiar with the computerized, mechanized systems of today's food production facilities to identify and control the potential hazards of such systems.

Changes in Understanding of Health and Safety

Next, I'd like to turn to changes in our understanding of health and safety. On this front I see three developments underway. Two of these I would characterize as "macro" developments, and the third as a "micro" development. The first "macro" development is one of which we are all aware and which has been well-discussed, but is SO important in the evolution of food safety issues that it must be mentioned. I'm speaking, of course, about changes in the nature of our food safety concerns -- the broadening of concerns from acute toxicity to chronic toxicity. Today, we focus on effects which may induce cancer or heart disease; tomorrow we worry about more subtle effects such as those regarding immune function and behavior; and we ask about the teratogenic potential of that which we consume.

This expansion of concerns has led, in part, to what I call the second "macrodevelopment," a growing interest in the total relationship between diet and health. I call it a macrodevelopment, for it reflects a change in our understanding of health targeted on aggregate, rather than individual, factors, including what we should be eating and their

relative proportions. This interest has manifested itself most dramatically through the issuance of numerous dietary guidelines. These guidelines have varied in advice, however, and a major issue which promises to be with us for some time is determining how diet as a whole influences health and risks of major chronic diseases. Nevertheless, in our concentration on the variations in advice given for protection against cancer or coronary heart disease, we should not ignore their convergence. All agree that a reduction in total fat and simple sugar and an increase in fiber are desirable and important. Part of the problem is the nature of nutrient interactions and our lack of understanding of their regulation. In a bold step to confront this issue, the Food and Nutrition Board of the National Academy of Sciences has undertaken a three year project to define the specific criteria used to assess the strength of the diet and health associations, and to propose dietary guidelines. The Board anticipates that this study may be just the first in a series similar to its periodic review of Recommended Dietary Allowances.

The microdevelopment to which I referred concerns our burgeoning knowledge of health at increasingly refined levels. Through advances in cellular and molecular biology, our understanding of health is changing at a "micro" level. "Old toxicology" focused on "lumps and bumps." Today, modern biology contemplates gene mapping, gene regulation, protein synthesis, cell membranes, and phenomena such as the regulation of cell function. Questions center on the roles of introns, and oncogenes, and neurotransmitters. Certainly, in the future, changes in our scientific knowledge will influence our interpretation of toxicity, its mechanisms, and our management of risk.

Socioeconomic Changes

The last set of changes I'd like to address are those falling into the socioeconomic category. Because our society is so amorphous and so mobile, these changes may be among the most difficult to anticipate, identify, and measure. Yet, they may have tremendous impact on food safety concerns and the allocation of resources to address those concerns. When the Delaney amendment was inserted into the Food Additive Amendments of the U.S. Food, Drug and Cosmetic Act in 1958, who would have expected that tampering, foodborne illness, and radioactive contamination would be major issues of 1986?

Today, we live in a global economy where safety must be considered on an international scale. Labor costs, and other economic factors are determining who produces what and where. As foods move across borders, most nations are struggling to assure adequate safety and standards of identity without imposing non-tariff trade barriers.

The influence of trade pressures on food production patterns remains unclear at this time. We could conjecture that some economies could or should focus on just a few key commodities while others may concentrate on a variety of smaller markets with value-added products having special characteristics such as insect resistance, nutritional quality, or a host of other possibilities. In addition to their benefits, if such economic paths are followed in food production, they could bring with them unique safety concerns such as special problems from over-reliance on chemical pesticides; alteration of dietary patterns; or increased exposures to certain natural toxicants. It is difficult to predict just what might happen. The point is, we must

remain vigilant to the possibility of new issues arising from such developments.

Socioeconomic factors can exert myriad influences in the areas of nutrition and food safety. In the United States, for example, there is growing interest in the "graying" of the country. By the year 2030, the fraction of the population over age 65 is expected to double to about twenty percent. Certainly, the aging population poses new sets of nutritional issues. Much of the elderly population will be women. We have already seen in the U.S. an explosion of interest in investigating the relationship between diet and osteoporosis. Other such issues, tied in large part to demographics, are sure to emerge.

Economic needs and lifestyle can often affect food safety issues in unexpected ways. We are seeing this point made in the U.S. where two incomes now are need to sustain many households. This development has led parents to return to work while their children are still infants, and the emergence of day care as an important aspect of society. The role of day care in the spread of infectious disease is now under consideration and the need for better training in food handling and other aspects of day care is being discussed.

NATURE OF EMERGING ISSUES

How will all of these changes and others along the way determine emerging food issues? I've tried to point out some of the ways as I've discussed the various categories of change. What I'd like to do now, is talk about the generic nature of these issues. Like the categories of change, I see three broad areas for emerging food issues. I believe we

will face issues in regulation and enforcement; issues in science; and issues in our institutional structures associated with food technology.

Enforcement and Regulation

I'd like to say only a few, brief words about issues in regulation and enforcement, for at present, it appears that the problems here will be primarily of boundary definition -- in other words, under what circumstances should existing laws and regulations be applied? We are facing that question now in our efforts to develop a threshold of regulation policy. Modern analytical chemistry has made it possible to detect minute amounts of substances which may enter food at the parts per billion level. This development poses many questions ranging from the biologic meaning of such trace levels to whether complete food additive petitions are needed for such trace substances. In the months to come, this issue will gain attention as the FDA examines large arrays of toxicological and carcinogenicity data in efforts to decide if a threshold of regulation can be adequately defined based on current knowledge.

On a larger scale, the introduction of new or modified foods poses the question of what, if any, provisions of our laws and regulations apply? For example, a substance could lose its "Generally Recognized as Safe" status under U.S. food law if the substance (and its contaminants) has been altered in such a way that as a result of its method of production (e.g., through biotechnology) it can no longer be generally recognized by qualified experts to be safe. In this instance, the

substance would be a food additive, and the more stringent provisions of the law relevant to food additives would apply.

As science improves our risk estimates and technology introduces the potential for new hazards or safer products, it is likely that enforcement issues also will emerge. New and better detection methodologies will be needed. For example, DNA probes now are being developed to assay certain infection organisms which may contaminate food.

Issues in Science

The issues in science arise from all of the categories of change I've mentioned. They are extensive, but also the most exciting. In the areas of nutrition and toxicology, we need greater scientific integration. We need a better understanding of the impacts of toxicants on nutrient functions and requirements, as well as the impacts of diet, foods, and nutrients on toxic endpoints. We also need integration between the toxicological and chemical sciences so that chemical techniques can aid in understanding metabolic systems and information obtained through in vivo and in vitro studies.

The mounting use of risk assessment also will stimulate numerous issues. Primary among these will be estimates of effective dose. We anticipate that interest in pharmacokinetics will grow and efforts to develop, validate, and use physiological based pharmacokinetic models for risk assessment will continue. Much work is needed on the measurement of input parameters in the models, and on sensitivity studies for model parameters subject to uncertainty.

Toxicologists will continue to be challenged by the simultaneous expansion of toxicological concerns and the introduction of new types

and varieties of foods. New techniques will be needed to assess effects on phenomena such as immunity and neurotoxicity. And interest undoubtedly will persist in developing less expensive and more effective alternatives to whole animal models.

The role and efficacy of foods for medical and special dietary purposes is another issue that will be important in future years. Procedures and standards for evaluating such foods are needed.

I mentioned before that we can't forget the impact of food distribution in thinking about emerging issues. Important to the distribution system is the matter of packaging. We have seen an explosion in new food packaging technology. Those changes, in turn, are necessitating expansion of our knowledge and expertise to address questions about the integrity of seals and containers, and the migration of chemicals from the packaging to food.

Unfortunately, foodborne illness is yet another generic area of newly emerging concerns. Here, issues abound. Our scientists estimate that, conservatively, 80 million cases of foodborne enteric disease occur each year, costing the U.S. economy about \$20 billion annually in direct costs. We need a better understanding of the scientific and socioeconomic factors affecting transmission and susceptibility. We need to develop new probes for detecting contamination. We need to better understand the chronic effects of periodic acute episodes of foodborne disease. We know, for example, that certain kinds of arthritis result from periodic exposure to certain salmonella. And questions about the relationship between foodborne illnesses and their effects on nutritional stress and the consequences of such stress also must be addressed.

The new biotechnology (as contrasted with the old) will bring with it, its own set of scientific issues. Information will be needed about cloned DNA; the vectors involved; the characterization of inserted DNA; documentation that the inserted DNA is free from sequences that code for harmful products; and other considerations unique to this technology.

Finally, I must mention the entire issue of exposure estimates. Better and more consistent data bases on dietary intake are needed. Their development is vital to improved nutrient and safety assessments.

Issues Concerning Institutional Structures

As you can see, the litany of scientific questions could go on and on. The thought I would like to leave with you today is that our issues are intricate and multifaceted. Gone are the days when we think about food-related toxicities in terms of single poisons and unique effects. Today we face a spectrum of concerns elicited by a complex, ever-changing flux of scientific and socioeconomic factors. As the industry has become more complicated, so have the issues. As our global ties and trade in food have become more far-reaching, so have the issues. And as our scientific knowledge has grown more sophisticated, so have the issues. Are and will the safety questions of the developed world be the same as those for the developing nations, with their different cultures, nutritional status, and economic situations? And how do we harmonize international standards? These are the types of questions we will be facing in future years.

This complexity brings me to the last generic issue I'd like to mention -- that of the societal institutions needed to prepare for and

respond to the changes occurring in our society today. We must develop appropriate mechanisms for solving the many issues we will encounter. If we are to approach problems in a broad-based fashion, we need the human and institutional resources to support such an approach. We must begin to consider how we can achieve the multidisciplinary education needed by our scientists and leaders involved with food policies. We also must consider the settings in which they will work -- the settings that inspire cooperation and that challenge thought.

CONCLUSION

There is no question that food safety will continue as an issue into and beyond the year 2000. But when we talk about food safety in the year 2000, we'll be studying the safety of food in its entirety, and that means all of the things that food is or represents will need to be examined simultaneously. Food safety will not only be an issue of protection, but also one of health maintenance and promotion. It will be all of those issues that compromise the role food plays in maintaining our lives and lifestyles.

Food safety cannot be an afterthought or a response to crisis. The concentration of the food industry, and its almost instantaneous marketing abilities has made it essential that issues of food safety be considered an integral part of national food planning. We no longer have the luxury of time, time to respond post hoc to crisis. Nor do we have the luxury of permitting amateurs, politicians or unsophisticated untrained bureaucrats to determine the issues and their solutions. We

need young, highly trained scientists, knowledgeable of the global impact of food safety, its dimensions, and problems. We also need greater support for research in food safety in its broadest sense. This means research not only in toxicology or microbiology, but also in nutrition, economics, food technology, and other disciplines.

Charles Dickens began a Tale of Two Cities by saying: "This was the best of times and the worst of times." That quotation, I believe, can describe us today. As a regulator and public official, I shudder at the problems we face and their possible consequences. As a scientist and public health official, I revel in it for the future holds a promise for a better, higher quality of life -- a quality society has only dreamed of. That, I believe, is the real promise of the future and the goal of agriculture for the year 2000.

Mr. VALENTINE. Thank you.
Dr. Goyer.

**STATEMENT OF DR. ROBERT A. GOYER, UNIVERSITY OF
WESTERN ONTARIO**

Dr. GOYER. Thank you, Mr. Valentine, Mr. Price and Congressional staff. I am very pleased to provide testimony to the Subcommittee. I also should introduce myself briefly. I was a member of the Pathology Department at the University of North Carolina at Chapel Hill for many years and served as the Deputy Director of this Institute. And most recently I am the Chairman of the Pathology Department at the Medical School, University of Western Ontario, Canada. Now in this statement, I would like to talk about the effects of acid precipitation or the acid rain phenomenon on toxic metals. My personal research interest for many years has been on the toxic effects of lead and more recently cadmium and other toxic metals. And I am fascinated by the way that this one environmental phenomenon affects—a relatively new environmental phenomenon—now affects one that we have had such a long interest in, that is toxic metals. And it does this by increasing the solubility of the metals in the soil and water, in mobilizing them into food so that the long term consequence is that it contributes to the increased human exposure to these metals.

Now my interest in acid rain began with a conference that was put on by this Institute that I was involved in that resulted in a publication of a number of papers related to the acid rain phenomenon and its potential health consequences. It is all presented in this issue of *Environmental Health Perspectives*.

More recently, I have had a personal experience that has continued my interest in the acid rain phenomenon and this is the acidity of the rainfall in the community where I now live. I moved to a town that has very little heavy industry, it is largely financial, insurance and university town. It is London, Ontario and the town is on the north shore of Lake Erie, it is located halfway between Detroit and Toronto and it is just northeast of the Ohio valley and western Pennsylvania. The local newspaper there, the *London Free Press*, weekly, in the Wednesday morning edition, publishes the pH of the recent rainfall as determined by a local conservation station, the Longford Conservation Station. And just before hearing about my invitation to come here, I read in the Wednesday morning paper that the rainfall for that week had gotten as low as 3.9 and the second rainfall was 4.0. And I had previously noted rainfall as low as a pH of 3.8. pH of 4 or lower is regarded as dangerous to the environment. Neutral is 7.0 and in normal rainfall it is about 5.7. So that a pH of 4 is considerably more acidic than it might be. The effects of this on the environment have been well-publicized, including effects on erosion of buildings, automobile paint, forestation, acidity of lakes, and there is an associated toxicity to the natural living ecology, that is the organisms that are living in soil and water. The most conspicuous of these, the effect that has received the most attention, is reduction in the fish population in lakes in North America.

Now it is not my purpose here to argue the causes of the rainfall, but it is to point out to you the potential effects on health, particularly due to the mobilization of metals and enhancing human exposure. Now the principal metals that are affected are the toxic metals lead, cadmium, mercury and aluminum, which may or may not be toxic. There is a more detailed publication of these potential health effects in this issue, but I will just briefly summarize what the impact on these four metals might be.

Acidification of streams, rivers and lakes increases the conversion of inorganic mercury to alkylmercury which is bioconcentrated in the aquatic food chain; that is, it is progressively increased in concentration in larger and larger fish. The route of exposure to man is almost entirely by way of consumption of fish and seafood. Now in some countries at the present time, intake by this route may approach levels that can give rise to health effects on population groups that depend on a high consumption of these items. The health effects are largely on the central nervous system and are not reversible.

The acidic rainfall increases the mobilization of lead from soil, so that greater amounts of lead are contained in food as well as increased level in drinking water sources. Furthermore, acidic drinking water supplies are corrosive to pipes and leach lead from solder producing a threat from increased lead in drinking water. I know that it is possible with the secondary treatment of drinking water sources that you can remove the metals, I think it is technically possible. But it is my understanding that there are very few communities that have the technology to do this. So I do not need at this point to comment further on health effects of lead, we did that yesterday to great degree, but I should say that after lead in air, it is the lead in water and food that will present the greatest need for control over the next few years.

Now there has been little concern for health effects of cadmium exposure by the general population in the United States to date since there has really not been a need for concern. But there currently is in some countries, particularly in Japan and specific communities in Europe where the soil has been polluted by industrial activities involving the refining of metals. Cadmium is a potential health threat to persons in the general population by way of accumulation in kidneys and producing kidney disease. Now cadmium accumulates in our kidneys over our lifetime and it seems to be harmless as long as the concentration does not exceed certain critical maximal level. But beyond that level, toxic effects do occur in the kidney and there is no known treatment. Even though it may take years to get there, once it has occurred, there is no medicine to reverse it. Nor is it really reversible except at its very early stages.

Now acidification of soil and water increases cadmium in food, which is the principal source of cadmium for the general population. I would like to present a brief anecdote that is recent. A colleague of mine, a scientist in the institute where I am working now, has been measuring cadmium content of moose kidneys from two different locations in Ontario. He is funded by the Wildlife Federation in Canada to do this. One area is an acid sensitive area and in another area the soil is relatively alkaline and contains

buffers that reduce the acidity of the rainfall. Now moose live on low shrubbery and foliage in a relatively small range of travel. The kidneys of moose in the acid sensitive areas contain about three times the cadmium of moose in the acid buffered areas. So in the acidic sensitive areas, the moose are consuming in their food plants at least three times the cadmium that the moose in the buffered areas are consuming. Now the levels of cadmium in the kidneys of these moose are a little less than toxic, they are near the toxic range. And the presumption is that people living on food supplies grown in these areas would have a similar exposure to cadmium. Now in terms of the general population, our food supplies come from all over, and at-variant effect like this might be diluted, but it does serve to show what the potential effects of acidification of soil are in accumulation of this metal.

Now I will only briefly comment on aluminum mobilization by acid rain because there is considerable uncertainty now regarding the toxicity of this metal. Aluminum content though of acidic water is greatly increased, and it is known that aluminum can cause central nervous system disease. This has been demonstrated in patients in hospitals in human dialysis units where the water in the dialysis machines contain excessive amounts of aluminum. Now whether the mobilization of aluminum by the acid rain phenomenon has an effect on people is not clear, but a third fact that is known is that people with Alzheimer's disease or certain forms of dementia, do contain elevated amounts of aluminum in the cells in their nervous system. The cause and effect relationships here are debated, but—and even less understood is the relationship to acid rain, but these facts have been noted and are real.

Now one final note in summary. I think it is necessary to take a very long term view with regard to the health effects of exposure to toxic metals. Metals cannot be destroyed or eliminated as organic chemicals can be. They are only mobilized by human activities. All the experiences that we have in the workplace and in the general environment with toxicity in metals are the result of man's activities, moving metal from its ores, refining it, manufacturing objects with it, exposing people some place along the way. And sometimes we transform the metal from a non-toxic to a toxic form. And often, as I pointed out, the effects of human exposure on the human effects of people is either difficult or impossible to reverse.

And the final comment I would like to make is that though the toxicity in metals has been long studies and we have been long aware of it, I think that this new awareness of the relationship of a second environmental problem aggravating the first or aggravating the old problem, is certainly worth considering. It is particularly pertinent at this time because it seems—you are all aware we have been fairly effective in reducing lead from gasoline, reducing air levels of lead and reducing blood lead levels in children. And here now we have another environmental problem that seems to be running counter to that, by increasing this metal in water and food.

Thank you very much.

[The prepared statement of Dr. Goyer follows:]

Statement to be presented to Subcommittee on Natural Resources,
Agriculture Research and Environment at Hearing on Environmental
Health in the Twenty-First Century, on April 6, 1988 at
Research Triangle Park, N.C.

Mr. Chairman: This brief statement is intended to broaden my comments made at the scientific sessions held yesterday and earlier today at the National Institute of Environmental Health Sciences. I spoke about the slow progress made over past centuries on the understanding of the health effects due to excessive exposure to lead and the great strides made in the past few years. I want to emphasize that the advances made in understanding the biologic or toxicologic basis for health effects due to lead exposure were possible because of Federal Support for basic research and the resulting advances made in understanding the cellular and molecular basis for disease. It is only with this scientific background we can judge the potential hazardous effects of substances in our environment.

In these brief comments today I want to bring attention to a twentieth century problem that we are only just now beginning to approach in a critical way and for which there is still considerable uncertainty and that is the problem presented to the environment and possibly to human health by the acid rain phenomenon. My interest and experience with this problem comes from two activities - my participation in a conference and workshop more than three years ago and my long interest and research activities on health effects of toxic metals.

When I was associated with the National Institute of Environmental Health Sciences I was involved in organizing a workshop and, a while later an international conference on the potential health effects of acid rain. The

proceedings of both of these activities are published in Environmental Health Perspectives (Goyer et al., 1985 and Report of Conference on Health Effects of Acid Precipitation, 1985). Another more personal experience that serves to continue my interest in this topic is the acidity of the rainfall in the community where I now live in London, Ontario, which is on the north shore of Lake Erie between Detroit and Buffalo but just north-east of the Ohio Valley and Western Pennsylvania. The local newspaper, London (Ontario) Free Press regularly publishes a report from the local Longford, Ontario Conservation Station. This past Wednesday indicated there were recent rainfalls of pH 3.9 and 4.0. I had previously noted rainfall as low as pH 3.8. pH of 4.0 or lower is regarded as 'dangerous' to the environment. Neutral pH is 7.0, and normal (pure) rainfall is about pH 5.7 so that pH 4.0 is considerably more acidic than it might be. The effects of this on the environment have been well-publicized including effects on erosion of buildings, automobile paint, forestation and acidity of lakes, and there is an associated toxicity to the natural ecology, that is organisms living in soil and water. The most conspicuous of these is the reduction in fish population of acidified lakes.

It is not my purpose to argue the causes of this rainfall but to point out to you the potential effects on health particularly due to the solubilization and mobilization of toxic metals. By this is meant that potentially toxic metals are made more soluble in water. The principle metals of concern are the toxic metals mercury, lead, cadmium and aluminum which may or may not be toxic. A review of the possible effects on health resulting from the acidification of water is contained in one of the papers published in the 1985 conference report (Nordberg et al., 1985). I will briefly summarize some of these effects.

Acidification of streams, rivers and lakes increases the conversion of inorganic mercury to alkylmercury which is bioconcentrated in the aquatic food chain, that is, it is progressively increased in concentration in larger and larger fish. The route of exposure to man is almost entirely by way of consumption fish and seafood. In some countries at present, intake by this route may approach levels that can give rise to adverse health effects on population groups that have a high consumption of these items. The health effects are largely on the central nervous system and are not reversible.

Acidic rainfall may increase mobilization of lead from soil so that greater amounts of lead are contained in food as well as increased levels in drinking water sources. Furthermore, acidic drinking water supplies are corrosive to pipes and leach lead from solder producing a threat from increased lead in drinking water. I know that it is possible with the secondary treatment of drinking water sources that this can be prevented, but it is my understanding that few communities have water treatment facilities with this level of sophistication. I do not need, at this point, to comment further on potential health effects of lead but I should say that, after lead in air, it is lead in water and food that will present the greatest need for control over the next few years.

There has been little concern for potential health effects of cadmium exposure by the general population in the United States to date because there has been no need for concern. But there is in some countries, particularly Japan and specific communities in Europe where soil has been polluted by industrial activities involving the refining of metals. And cadmium is a potential health threat to persons in the general population by way of accumulation in kidneys and producing kidney disease, (renal tubular dysfunction). Cadmium accumulates in kidneys over our lifetime. It seems to

be harmless as long as the concentration does not exceed a critical maximal level. Beyond that toxic effects to kidney cells occur and there is no known treatment. Whether removal from exposure reverses the kidney disease is not certain, perhaps at minimal levels of toxicity but not at higher levels, and there is no known treatment. Acidification of soil and water increases cadmium in food which is the principal source of cadmium for the general population. A colleague in Canada, Dr. George Cherian, has been measuring the cadmium content of moose kidneys from two locations in Ontario, one an acid sensitive area, and another area where the soil is relatively alkaline and contains effective buffers to acid rainfall. Moose live on low shrubbery and foliage in a relatively small range of travel. The kidneys of moose in the acid sensitive area contain about 3 times the cadmium of moose in the acid buffered area. Though the highest levels of cadmium in these moose are less than toxic, they are near the toxic range. The presumption is that people living on food supplies grown in these areas would have a similar exposure to cadmium.

I will only briefly comment on aluminum mobilization by acid rain because there is considerable uncertainty regarding its toxicity. Aluminum content of acidic water is increased, aluminum can cause central nervous system disease in patients in hospitals with kidney disease (hemodialysis syndrome) and it is in increased amounts in brains of people with various dementias (Alzheimer's disease). How or if these observations are related is not understood at present but it is clear that acid rain does increase mobilization of aluminum in water supplies.

One final note in summary, it is necessary to take a longterm view with regard to possible health effects from exposure to toxic metals. Metals cannot be destroyed or eliminated as organic chemicals might be. They are

only mobilized by human activities and sometimes transformed from non-toxic to toxic forms, or increased in ways that increase human exposure as in food supplies and drinking water. Correction or reversal of such effects is difficult if not impossible in some cases.

References:

- Goyer, R.A., Bachmann, J., Clarkson, T.W., Ferris, B.G., Graham, J., Mushak, P., Perl, D.P., Rall, D.P., Schlesinger, R., Sharpe, W., and Wood, J.M. Potential Human Health Effects of Acid Rain: Report of a Workshop. Environ. Health Perspect. 60: 355-368, 1985.
- Proceedings of a Conference on Health Effects of Acid Precipitation. Environ. Health Perspect. 63: 1-182, 1985.
- Nordberg, G.F., Goyer, R.A. and Clarkson, T.W. Impact of effects of acid precipitation on toxicity of metals. Environ. Health Perspect. 63: 169-180, 1985.

Mr. VALENTINE. Thank you, Doctor.
Dr. Silbergeld.

**STATEMENT OF DR. ELLEN K. SILBERGELD, ENVIRONMENTAL
DEFENSE FUND**

Dr. SILBERGELD. Thank you very much, Mr. Chairman and Mr. Price. Also I am very grateful for the opportunity to be able to discuss with you some of the conclusions and thoughts that have arisen in these past two very exciting days.

I am the senior scientist in the toxic chemicals program at the Environmental Defense Fund in Washington, D.C.

What we have learned I think in the past two days which is noteworthy to pass on, is that, not surprisingly, what has happened in the past which will undoubtedly inform the debates and the crises and the concerns of the future. Environmental health presents both in terms of what I might call long rolls of history, slowly unfolding problems, as well as sudden jumps and apparent crises of unperceived events which suddenly come to the attention and concern of the public.

I would like to illustrate some of those in the remarks I make. In addition, I think what we will see over the next decades is an unfolding of a realization within the public and a recognition and response by our Congress if not always by the appropriate agencies, that in fact the way in which we have managed and perceived environmental health issues has been grossly negligent. The bills are really coming due and they are coming due in the end stages of the problem, which we know from the medical and health care area is the most expensive stage of treating a problem. We have now a Superfund program in this country which is one of the single most expensive environmental programs we have ever undertaken. I think Congress and the American people recognize how this program is really a closing of the loop too late, and a dealing with the problem after it has wreaked its most extensive, persistent and difficult to remediate aspects.

We see people looking at the management of incineration of municipal waste, the management of hazardous waste and saying no, we cannot defer these problems to the end stages, we must start asking how they got to this point. How did we end up with this extremely toxic material to be disposed of at the end of its life history?

So I would suggest that we are at last being directed back to the beginning. And I would urge Congress particularly to take very careful scrutiny of those landmark items of legislation which in fact were designed to insert controls and responsibility at the initial stages of potential health threats and ecological threats, specifically to reconsider the performance of the Toxic Substance Control Act in the hands of the Environmental Protection Agency. I think I can say without exaggeration that the first decade history of that Act has been an abuse of discretion. It is time for Congress to examine the loopholes in that law to take charge of the preventive burden of proof shifting philosophy that was instituted in that law, and make sure that we in fact start the dual process of ensuring that new chemicals, new processes do not enter our environment

without at least some information, and that we begin the long and arduous process of catching up with those materials in our food supply, air and water, which have very little data at all.

We can expect that the new changes that we see in the workplace and in technology will be harbingers of effects and impacts on environmental health. I would like to submit for the record, Mr. Chairman, a draft manuscript co-authored by myself and Dr. Bruce Fowler at the University of Maryland, on occupational disease, new work forces and new work places, which describes some of the potential impacts in the area of micro-electronics, super-conductivity, hazardous waste management, source reduction, biotechnology as well as the interaction of these workplaces with new working populations, demographic changes in the population and very major advances which Dr. Rall alluded to in our detection both of contaminants, as you mentioned, and exposures and earlier markers of biologic effect.

[Copy of draft manuscript follows:]

OCCUPATIONAL DISEASES -- NEW WORKFORCES, NEW WORKPLACES

BRUCE A. FOWLER

University of Maryland at Baltimore

Toxicology Program

Baltimore, Maryland 21201

ELLEN K. SILBERGELD

*Univ of Maryland at Baltimore**Dept of Neurology**AND**Environmental Defense Fund**Washington DC 20036*

INTRODUCTION

A conference on the subject of occupational medicine is a timely opportunity to establish rational plans for reforming strategies and to determine what issues are likely to arise in the near future. This paper deals with the impact of three rapid changes in occupational health in the future, and with new techniques for recognizing and dealing with health effects in the workplace. The three changes, which are in process right now, relate to the workforce, the workplace, and the definition of adverse health effects in working populations. It is the thesis of this paper that periods of change, like the present, provide opportunities to learn from the past in order to more effectively prevent occupational disease in the future.

Two major changes in the workplace which will greatly influence the types of occupational diseases that are likely to occur over the next decade are: the demographic: the U.S. workforce is becoming less homogenous as a result of several socioeconomic factors and the second is technological: new substances and new uses of old materials are being exploited in new industries, organized in novel workplace structures. The third factor concerns the fact that new approaches to detect and assess the significance of early chemical-specific events in the progression of cell response and injury will change present concepts of disease and definition of toxicity. It should be a goal of all the sciences, clinical disciplines, and regulatory authorities associated with occupational health policy to marshall this new knowledge into an efficient and responsive program which will permit early detection of insidious chemically-induced systemic organ damage before overt clinical toxicity occurs in workers exposed to new classes of chemical toxicants found in new industries or new settings of work.

1. CHANGES IN THE WORKFORCE

The U.S. workforce has undergone significant demographic changes over the past decade. Women, a broader range of racial and ethnic groups, and a wider age range of workers, are now employed (Table I). More than half of all women between 18 and 65 now work outside the home (Table II); many teenagers work at least part-time, and many persons for economic reasons, or by choice, prolong employment beyond

the legal retirement age of 62. Large shifts in the U.S. population over the past two decades have increased the percentage of Hispanic and Asian ethnic groups in the working and general population. Moreover, many of these groups are now employed in occupations formerly closed to them.

These changes have many impacts on American society. Within the context of this paper, the diversification of the U.S. workforce raises concerns about the validity of current occupational health standards based upon a reference population of young white males. While we cannot, based on present knowledge, incorporate considerations of genetic or phenotypic heterogeneity into occupation health policy or clinical medicine, the increased diversity of the working population should be a basis for assuming a wider range of responses to chemical exposures (for instance in the case of immunology and aging¹).

In one obvious area, assuming a homogenous workforce limits detection of effects which may occur in the modern workforce. Reproductive toxicology has historically not been a major occupational health concern, when it could be assumed that workers -- particularly in the chemical industry -- were male. This assumption, which was not well founded in science, that relatively few toxins affect the male reproductive system to reduce fertility or to affect

the fetus has lead to a number of cases of chemical-induced infertility for agents such as kepone and ethylene dibromide. With the entry of women into employment where toxic chemicals are present, all three organisms of reproductive importance -- male, female, and the fetus-- are potentially present in the occupational environment. The social response to this change over the past decade has been repressive: ~~directed~~ perceived risks have been reduced by restricting the opportunities for women's employment rather than by reducing the presence of the toxins in the workplace environment². As women become increasingly represented in such occupations, this policy has been legally ruled as blatantly discriminatory. It is critical that we do not repeat this pattern of protecting the workplace from the worker, rather than the other way around, at such time as accurate methods are validated which permit identification of subgroups within the working population with genetically responsiveness to toxic chemicals.

Second, workers are now being employed in different settings from those where opportunities for chemical exposure have traditionally occurred. As discussed below, many new technologies are evolved as small entrepreneurial businesses - some even starting in garages - in small scale operations where unionization rarely succeeds and where the size of operation is insufficient to support corporate medical departments, epidemiological services, toxicology research,

or other activities which facilitate - although they do not guarantee -- early detection and long-term follow-up of occupational diseases. Very broadly speaking, chemical exposures in operations of the present or future where contact with new hazards may occur will most likely involve these new companies. In the absence of unionization, worker rolls for retrospective epidemiological/clinical studies will not be available; in workforces with high dependence upon part-time or contractural workers, there may be no medical record keeping. It will be difficult even to use hospital records or admissions for surveillance purposes³. (AJPH).

2. NEW TECHNOLOGIES AND WORKPLACES

One occupational category which has grown in response to new obligations in environmental policy, concerns waste management and hazardous waste cleanup. This latter activity is now budgeted at \$12 billion dollars over the next five years of the National Superfund law; in addition to these federally authorized activities, private sector waste management and remedial actions will involve further multi-billion dollar resources. The need to develop new worker education and protection methods in these novel situations has been recognized, and NIOSH has been authorized under the Superfund amendments to develop model worker training and education programs for hazardous waste workers.

Hazardous waste management and cleanup are remarkably diverse activities. Cleanup includes decontamination of buildings and other facilities, detection of hidden wastes, removal and storage of wastes, detoxification and destruction technologies, and construction of barriers between wastes and environment. Hazards of such activities include dangers of explosion and fires, contact with highly corrosive agents, and materials of unknown toxicity in highly complex mixtures, presenting in all potential routes of exposure. At most sites where wastes have been poorly managed, there is little information as to the specific materials on site, or amounts of such materials, or the degree to which they have already been released from drums or other containers. As shown in Table III, many well known toxic materials -- including halogenated hydrocarbon solvents, pesticides and metals -- have been frequently detected at hazardous waste dumpsites. Experience has shown that under such circumstances, workers can become exposed to hazardous substances in waste, as shown by a study by Baker et al⁴, on PCB uptake by sewage treatment workers.

Because of the range of uncertainty as to hazards involved on these occupations, most workers are required to wear a high level of personal protective gear, including complete covering with impermeable material, enclosed breathing apparatus. In addition, many operations have set up medical monitoring and continued surveillance as requirements for

cleanup crews. The experience of New York State with decontamination operations at the Binghamton State Office Building exemplifies a strategy developed to deal with such uncertainties⁵. In this situation, a program for clinical monitoring and follow-up, past the time of completion of employment in this job, was instituted. Workers' blood is periodically sampled and assayed for the presence of PCBs, and for certain endogenous materials thought to be biological markers for exposure to PCBs and related compounds, specifically plasma triglycerides and serum enzymes of liver cell origin. A pre-employment clinical examination was developed to derive a "baseline" health status record against which post-employment exposure and medical history could be tracked.

- a. During the past decade there has been a marked growth in the semiconductor microelectronic industry with increases in the utilization of some novel organic, inorganic, and organometallic compounds. In particular, expanded development of III - V semiconductors such as gallium arsenide (GaAs), has introduced a number of new compounds and manufacturing procedures into the workplace. The toxicological database for these agents, is currently extremely limited or non-existent, such that it is extremely difficult to predict potential risks to workers in this industry. It is worth noting, however, that women comprise

approximately 50 percent of this workforce () and that, as noted above, this demographic pattern raises special concerns with regard to non-carcinogenic endpoints in this working population.

b. Biotechnology

Biotechnology is another new, and rapidly developing industry with enormous potential but again an industry which utilizes a number of unusual chemical reagents and biological entities in unique ways. At present, the toxicological potential of many of these agents has not been completely evaluated from the perspective of product safety, occupational health or environmental consequences. This rapidly expanding field hence represents a special challenge to toxicologists, occupational health physicians, and regulatory agencies since it will require the development of new approaches for assuring the safety of both this new technology and its products.

c. Service/Office Sectors

It is widely recognized that the U.S. economy is shifting from a basic industries base to one in which most jobs will be in the service industry and in offices. Such workplaces are not usually thought of as involving exposures to hazardous substances, although they may be stressful^{2,6}. However, the service sector

includes opportunities for contact with cleaners and fumigants, some of which have been found to be mutagenic and otherwise toxic. Office workers increasingly work with computers, and the health concerns over VDTs remain unanswered³. Moreover, the physical structure of such workplaces may itself impact upon workers' health: the "sick building syndrome" has been described as a condition in office workers resulting from exposure to chemicals released from synthetic materials in office products and furniture, which become concentrated in the air because of the low-ventilation rate of modern office buildings (AVPH). Experience with formaldehyde demonstrates how deleterious such exposures can be. Formaldehyde is released from a variety of wood products made with urea-formaldehyde resins and from urea-formaldehyde foam insulation materials; concerns over the possible carcinogenic properties of formaldehyde have curtailed its use in the U.S. However, the reports on neuropsychological dysfunction in workers exposed to formaldehyde vapors in enclosed spaces clearly show its toxic effects (Table III). In the study of workers in a Danish nursery school, in which formaldehyde-treated pressboard was used extensively, a range of sensitization-like and neuropsychological problems were reported by workers including nausea, headaches, muscle aches, and itching.

3. CHANGES IN BIOMEDICAL UNDERSTANDING OF OCCUPATIONAL DISEASES

The advent of new approaches for assessing preclinical toxicity from low-dose exposures to chemical mixtures in recent years has the potential for markedly improving our ability to detect and to specify the chemical species responsible for an observed biochemical or physiological change. This area of research, on biological markers, will change the manner in which we define both exposure and effect⁷. It is envisaged that as analytical methods are refined, and relationships further established between biological indicators and cell injury, these tools will provide a new foundation for risk assessment and regulation. Even in the absence of validating studies on the predictive power of such markers (e.g., long-term prospective follow-up) the detection of such alterations, in the context of ever more biochemically oriented medicine, will stipulate debates as to the appropriateness of reducing exposures.

Some specific examples of these biomarker approaches are discussed below:

- Chemical-induced alterations in heme/porphyrin metabolism
- Two-dimensional gel electrophoresis of "Stress Protein" induction patterns
- In vivo x-ray fluorescence (NMR) Spectroscopy of Tissue ATP Concentrations or Altered Metabolic Products
- In vivo X-ray Fluorescence (XRF) of Lead Deposition in Bone

a. Chemical-Induced Alterations in Heme/Porphyrin Metabolism

The heme biosynthesis pathway is highly sensitive to a wide variety of both organic and inorganic chemicals⁸. Chemically-induced selective inhibition of enzymes in the pathway with resultant urinary excretion of specific porphyrin/heme precursors has been effectively used for a number of decades to monitor the in vivo bioavailability of major toxicants such as lead. This class of biomarkers has been recently expanded, in experimental systems, to include III-V semiconductors such as gallium arsenide⁹⁻¹² (Figure 1) and as such offers great promise for detecting ongoing cell injury, at intermediate dose levels, before overt clinical manifestation of toxicity. The point here is that this well-established and understood class of biomarkers with a long history of both clinical and experimental usefulness may also be readily applied now to new classes of chemical toxicants.

b. Two-Dimensional Gel Electrophoresis of "Stress Protein" Induction Patterns

There are several techniques which hold great promise for the early detection of biological changes at the biochemical levels. One of these is the advent of computerized image analysis of 2-dimensional gel electrophoretograms (Figure 2) for monitoring "stress protein" induction patterns in target tissues which represent early genetic responses to chemical insult. With further refinement, these techniques may provide new levels of sensitivity for "fingerprinting" chemical insults at the genetic level of biological organization¹³.

c. In vivo Nuclear Magnetic Resonance (NMR) Spectroscopy of Tissue ATP Concentrations or Altered Metabolic Products

In vivo nuclear magnetic resonance is another technique which has been recently extended¹⁴ for non-mammals measuring changes in cellular energy metabolism (e.g., ATP levels) following acute exposure to toxicants which disrupt this essential cellular function. Again with refinement and further development of correlations with other

morphological or biochemical parameters if cell injury such that this technique may be utilized as a biomarker for monitoring injury in vivo. Other investigators¹⁵ have used proton NMR to monitor changes in urinary excretion of metabolic products.

- d. In vivo x-ray fluorescence has recently been used to evaluate bone stores of metals such as Pb which are extensively deposited in the skeleton 95-16 where they may be later mobilized, thus resulting in a chronic exposure condition which persists decades after occupational exposure has ceased.

4. CONCLUSION

The changing aspects of the workplace and the workforce, coupled with changes in methods available for assessing chemical changes need to be accommodated within new strategies for preventing occupational disease. Fundamentally, all these changes are likely to make disease prevention more complex. To prevent repeating the past, several changes in health policy and strategy are clearly necessary. First, we should more strategically anticipate the introduction of new substances, or in the case of biotechnology - new organisms, into the workplace and provide for the accumulation of the necessary toxicology data for assessing likely risks. This is not done in anything like a timely fashion at present, and is important

that state, federal and international agencies begin taking prospective approaches to these new industries or processes. For example, when the recent extraordinary advances of superconductivity are deployed into application, we can already anticipate that some very exotic organometals will be put into production -- ytterbium and yttrium compounds have already been shown to support superconductivity. We know nothing about the toxicity of these metals or of the organocomplexes used in superconductivity experiments; yet it is reasonable to anticipate that such organometals may well be biologically active; the nondegradability of metals as elements means that once released they will probably accumulate within the environment over time, as lead, mercury, manganese, and cadmium have already shown us. It is critical to activate the principles of the Toxic Substances Control Act in order to obtain the necessary information to reach reasonable decisions about risk before such compounds become widely dispersed in commerce and the environment. For materials which are not new but are newly exploited in new technologies, it is important that the powers of the "significant new use rule" in TSCA be expanded and implemented to catch these changes in potential exposure before they occur.

TABLE 1:

Labor force participation rate for women by presence and age of children, 1960-1987
(March Supplement)

	OWN CHILDREN UNDER 18	OWN CHILDREN UNDER 6
1960	30.4	20.2
1961	32.7	22.1
1962	32.9	22.8
1963	33.9	24.4
1964	34.5	24.5
1965	N/A	N/A
1966	35.8	26.2
1967	38.2	28.7
1968	39.4	29.2
1969	40.8	30.4
1970	42.0	32.2
1971	42.2	31.4
1972	42.9	31.9
1973	44.1	34.2
1974	45.7	36.6
1975	47.3	38.8
1976	48.7	39.8
1977	50.7	40.9
1978	52.9	43.7
1979	54.5	45.4
1980	56.6	46.8
1981	58.1	48.9
1982	58.5	49.9
1983	58.9	50.5
1984	60.5	52.1
1985	62.1	53.5
1986	62.8	54.4
1987	64.7	56.7

SOURCE: March supplement to the Current Population Survey
U.S. Bureau of Labor Statistics

TABLE II: Distribution of Employment by Race and Sex (Percentage)

Technicians & Related Support	2.8	3.2	1.8	3.2
Clerical & Administration	5.5	29.5	9.2	26.4
Service (Non-Household)	6.0	14.8	13.7	23.3
Precision Production, Craft & Repair	20.6	2.3	15.5	2.0
Machine Operators, Assemblers & Inspectors	7.2	5.9	10.8	10.3

SOURCE: U.S. Department of Labor, Bureau of Labor Statistics, Employment & Earnings, January, 1988

REFERENCES

1. NAGEL, J.E. & ADLER, W. H. 1987. Effects of Aging on Immune Function and Reserve Capacity. In BURGER, E.J., TARDIFF, R.G. & BELLANTI, J.A. (eds) Environmental Chemical Exposures & Immune System Integrity. Princeton Scientific Pub. Co., Princeton, N.J., pp. 195-203.
2. BERTIN
3. LANDRIGAN, P.J. 1983. Toxic Exposure and Psychiatric Disease - Lessons from Epid. of Cancer. *ACTA Psychiatrica (SCUND)*, 67 Supplement 303, pp. 353
4. BAKER
5. HELIUS
6. MATTISON & SILBERGELD
7. NRC, Committee on Biological Markers 1987. Biological markers in environmental health research. *Environ. Health Perspec.* 74: 309.
8. SILBERGELD & FOWLER
9. WEBB et al
10. GOERING & FOWLER
11. GOERING & FOWLER
12. BAKEWELL
13. N. L. ANDERSON
14. CHEN, B., BURT, C.T., GOERING, P.L., FOWLER, B.A., and LONDON, R.E.; In vivo ^{31}P nuclear magnetic resonance studies of arsenite-induced changes in hepatic phosphate levels. *Biochem. Biophys. Res. Commun.* 139: 228-234, 1986.
15. NICHOLSON, J.K. and GARTLAND, K.P.R. 1986. A nuclear magnetic resonance approach to investigate the biochemical and molecular effects of nephrotoxins on cells, membranes, and disease including renal. REIN, E., COOK, G.M.W. and LUZIO, J.P.. Plenum Press, New York. pp. 397-408.
16. SOMERVILLE
17. SHERWZ

Dr. SILBERGELD. I would like, however, to include in talk, if I might, something of the long roll of history and environmental health and I think as Dr. Goyer has mentioned, the metals are one of the major instances of that long roll. It may seem strange to you that we devoted significant periods of time in a conference on the 21st Century to some toxins that have been around since the Second Century B.C., and perhaps that is a comment on medical and biological research. But there are some lessons I think we can usefully learn.

If it would not be too much—if I might show some slides, Dr. Rall? Is that all right to displace these gentlemen from the stage and ask for the showing of a few slides?

Mr. VALENTINE. Displace us?

Dr. SILBERGELD. Yes, sir.

Mr. VALENTINE. I think that is an innovative idea.

Dr. SILBERGELD. Too innovative?

Mr. VALENTINE. No, no, that's great.

Dr. RALL. Can they not just turn around?

Dr. SILBERGELD. It is really up to your audio-visual.

Dr. RALL. Let us run one of the screens down.

Mr. VALENTINE. It looks kind of like a guillotine. [Laughter.]

Dr. RALL. If we can project it on that, then you do not have to move, you just have to get a crick in your neck.

Dr. SILBERGELD. I apologize for that in advance.

What I want to talk about is in fact a combination of one of these long rolls and jumps, if you will, in that based on the long roll of history of what we know about metals in the environment, primarily from the kind of work that Dr. Goyer and others have been involved in on lead, there was in fact one of those sudden jumps that almost occurred, which I think we should take better notice of when we think about how we are going to deal with these problems.

There was a proposal approved in a very alarming fashion by the EPA, in a way that did not pass through any health review or environmental review, to put manganese, organo-manganese as an additive in vehicle fuels. And I have entitled this "How not to learn from 50 years of lead in gasoline", so if you will, we are moving ahead to the year 2024 and simultaneously back to 1924 when the proposal to put lead in gasoline was first enunciated.

I do not seem to have any control in here—if I could have the next slide. Thank you.

The proposed uses were in fact as an additive to gasoline, that it would be installed in certain cars as an on-board fuel treatment; that is, a canister of highly concentrated organo-manganese would be installed on cars, or alternatively as a consumer product added by the consumer to his or her gas tank. The sources of exposure therefore could include the occupational cohort, manufacturing and packaging this material, the general population involved in its use, the disposal of waste material. We now know that waste oil, for example, from cars is a very highly concentrated form of lead, and those involved in automobile repair and maintenance could also be expected to come in contact with this material.

We did not know very much about the toxicology of manganese, but we knew something. We knew that it seemed to have specific

target organs of the brain and the lung, and that there might be in fact specially susceptible populations, the fetus because of general concerns about neurologic and lung development which may get compromised with respect to toxic exposures, and in the case of manganese very interestingly possibly the aged population because of its neuro-toxic effects particularly on those parts of the brain which undergo specific depletion during aging and are associated with major neuro-degenerative disease, the movement disorders, Parkinson's disease. We had some information, very limited, from occupational studies done in Chile and Morocco of very high dose inhalation exposures to manganese and some exciting but very inconclusive studies of lower dose through the drinking water done very recently.

So the picture was I think probably similar to lead in 1924. Now what are the lessons of lead that we should apply in a preventive manner from dealing with manganese and if you wish by extension, many other metals which are under consideration in micro-electronics and in super-conductivity, because I think as Dr. Goyer has said, metals represent a class of major concern because of their physical chemical characteristics. And we are not through with the exploitation and novel uses of metals. This is just one example.

We should know from lead that there is a major impact of mobile dispersive sources, that there is a particular biogeochemistry of metals in the environment, that they exemplify problems of cross media interactions because of their conservation and immunity from destruction. Because of that, there are both primary and secondary routes of exposure, and for many organisms including ourselves there is cumulative deposition and uptake. Within ourselves and other organisms there are long-term storage sites which may in fact over time and with aging serve as depots for mobilization, re-exposure from these internal dosage sites, and that there are very good correlation, as has been shown with lead, between uses, macro-uses such as inputs into gasoline and human body burdens.

If I might just give you a little more detail on these lessons because I think we have got to learn them before we start introducing chemicals which behave like lead. Mobile dispersive sources have both local and long-range effects, they can impact upon the entire geosphere in terms of the concentrations of metals in compartments. Their behavior depends highly upon particle size and therefore upon the specific modes of release. In addition, for vehicle fuels and probably for the organo-metals which might be used in super-conductivity, there will be both oxides of these organo-metals and uncombusted or virgin forms of these materials. Because of the speciation of metals in the environment, their biogeochemistry, the long-term behavior of them in various compartments such as the marine environment and in the gut will have a great deal to do with their actual state and hence their compartmentation and fluxes in and out of compartments in the environment and organisms.

As I mentioned, their opportunities for cross media transfer are unparalleled, unequalled. We have to look at pathways from initial sources of emission, such as air emission or industrial sources, and finally their behavior in waste disposal. The story of lead, I think, is exemplary.

As I mentioned, because of cross media, we have to consider primary and secondary routes of exposure. I do not need to tell some of the people in this room how long and fruitlessly we argued what now seems a ludicrous concept as to whether a person could be directly poisoned by breathing lead contaminated air, paying no attention to the post-deposition accumulation and exposure to lead through food, through drinking water, through dust and surface soil, which we now know is the overwhelming route of human exposure. We must not repeat that modeling and one-sided view of how humans interact with substances like this.

Because metals are never broken down, they have a cumulative deposition behavior, they are recycled within the environment, they are re-entrained and their stability as I mentioned is unparalleled.

And finally, also within biological organisms including ourselves, these same cumulative storage behavior patterns occur with metals. These influence very strongly the toxico-kinetics, how they move within our bodies and the bodies of the organisms that we feed upon, and they lead to a very extensive interplay between ongoing external exposure sources and the mobilization and re-exposure from internal sources within our bodies.

That is it for this multi-media part of what I wanted to say.

To give you just one other example of a fast jump, if I might, in the area of environmental health which I found myself totally unprepared for—I mentioned it to Dr. Rall, and I think it represents a challenge which shows how much we need research, we need to be armed to be able to answer critical questions. I received a call late last night from a colleague representing an ongoing very intensive effort to negotiate changes in the use of chlorofluorocarbons. As you know, Mr. Chairman, there has been considerable concern about this chemical class and its impact upon global climate, and many have heralded the decision by duPont and the treaties negotiated by Mr. Thomas as landmark steps in global interaction and cooperation, responsible reactions by industry to the targeting of a major global environmental impact. That is, the substitution of much less damaging chlorofluorocarbon species for those that now seem to be well implicated in the destruction of our protective ozone layer.

What I was asked, was this; suddenly an issue came up as to whether these substitutions, these chlorofluorocarbons with much less damaging properties in terms of atmospheric physics, whether in fact they had immediate toxic effects, and their introduction into aerosols and other uses might bring about human health damage of an acute nature that was not well understood and should be taken into account before we endorse this march towards the substitution. No one can answer that question. This substitution may take place over the next few weeks. We may have a massive introduction of a chemical which because it is an existing chemical will not be caught even by a newly invigorated EPA. Because it has no test data, getting it into the kind of machinery that Dr. Rall has at his resources will be very difficult without the resources needed. But these are the kinds of sudden jumps that will confront us every day. And I think this event will probably take place. If it has an effect, we will be chasing after it, as we have

chased after so many other environmental problems in the 20th Century.

Thank you very much.

Mr. VALENTINE. Thank you, Doctor.

Dr. Sexton.

STATEMENT OF DR. KEN SEXTON, DIRECTOR, OFFICE OF HEALTH RESEARCH, U.S. ENVIRONMENTAL PROTECTION AGENCY

Dr. SEXTON. Good afternoon, Mr. Chairman and members of the Committee, I am Director of EPA's Office of Health Research and currently acting Director of the Health Effects Research Laboratory just across the way. I thank you for the opportunity to provide you with my perspective on emerging and future trends in environmental health.

The field of environmental health has progressed rapidly over the past 20 years and has contributed greatly to our awareness and understanding of the link between environmental contaminants and human health. Since about 1970, our expanding knowledge of sources, ambient concentrations, environmental exposures, and human health effects has led to enactment of important environmental laws that are aimed at protecting public health, such as the Clean Air Act, the Safe Drinking Water Act and the Resource Conservation and Recovery Act. The U.S. Environmental Protection Agency is responsible not only for implementing these federal statutes, but also for supporting and carrying out research to improve our regulatory decisions.

The EPA health research program is mission oriented and necessarily spans the gamut from basic to applied. It falls mainly into four general areas: (1) development of better methods for characterization of health risk, primarily through application of improved statistical methods; (2) development, improvement and validation of test methods for use by others; (3) generation of dose-response data for specific environmental agents; and (4) improvement of the agency's ability to perform health risk assessments. The program encompasses all types of environmental health research, including in vitro and in vivo animal experiments, human studies using in vitro, clinical, and epidemiologic approaches, and investigation of structure-activity relationships.

With the start of the 21st Century only 12 years away, this is obviously an appropriate time to take stock of the field and to examine, as best we can, the nature of environmental health issues that are likely to confront us in the next century. Unfortunately, it is always easier to chronicle the past or document the present than it is to anticipate the future. Nevertheless, it is clear that some environmental health issues and trends are likely to continue to have significant ramifications well into the 21st Century.

One important trend that we can be sure will have significant implications for the field of environmental health is our ever-expanding ability to detect subtle health effects and to establish their causal association or lack thereof, with chronic low-level exposures to environmental contaminants. Just as the state-of-the art in environmental monitoring has progressed so that it is now possible to

measure pollutant concentrations at the part-per-trillion level, so too will our capabilities to detect subtle health effects continue to be enhanced over the coming years. As our understanding of the basic biologic mechanisms that underlie both cancer and non-cancer effects improves, our ability to perform quantitative health risk assessments will also improve. This in turn will help us make better decisions about the protection of public health.

Because the EPA is responsible for interpreting the available data and for applying those data to regulatory decisions, advances in the state-of-the-science often raise questions as well as present opportunities. For example, our enhanced ability to measure subtle biological changes challenges us to interpret those changes in terms of their relationship to injury or illness. The difficult question is when should a measurable biological effect be considered an adverse health effect. This is a critical question for the agency as we move into the 21st Century.

Among the key issues that are most likely to have an impact on environmental policy and research planning into the 21st Century are:

Non-cancer health effects—it is now clear that there are often a variety of health outcomes associated with an environmental insult. This realization has focused increased attention on the need to obtain appropriate data on non-cancer health effects. It is often unclear, for example, which health endpoints are important, for which agents and in what kinds of situations. Improvements in our ability to make reliable estimates of non-cancer health risks will aid in making informed judgments about protection of public health.

Molecular epidemiology—the possibility of using biological indicators to link individual exposure with health outcome is rapidly becoming a reality. The use of these techniques within the context of epidemiologic investigations offers a means to more directly assess health risks, and thereby reduce the uncertainties associated with risk estimates.

Complex mixtures—environmental exposures typically occur not to a single pollutant, but to a complex mixture. Research to determine which components are most toxic, mutagenic or carcinogenic and to assess whether health risks are additive for the individual components of the mixture will continue into the foreseeable future. The results of this research could have important implications for the way we address problems such as urban air pollution and drinking water disinfection.

High risk groups—our ability to identify population subgroups who are at increased risk as compared to the general population is steadily improving. Advances in our understanding of biological predisposition to a particular health effect and in our knowledge of human activity patterns that give rise to elevated exposures will continue to help us focus the agency's research and regulatory efforts on the appropriate groups.

Hazard identification—it is critical to determine in a timely manner whether there is a causal relationship between an environmental factor and an adverse health outcome. Currently, there are several issues and/or technologies for which the hazard identification process is ongoing, both inside and outside the agency. Exam-

ples include human exposure to non-ionizing radiation; chemicals used in the micro-electronics industry; methanol used as a fuel additive and environmental release of genetically engineered micro-organisms.

Both research and regulatory decisions will be affected by the outcome of these evaluations.

In summary, the EPA maintains an active involvement and interest in non-cancer health effects, molecular epidemiology, complex mixtures, high risk groups and hazard identification through its health research program. The agency is committed not only to improvement in the quality and quantity of the available data, but also to the appropriate interpretation and the proper application of those data to decisions about protecting public health. In addition, the EPA is dedicated to better utilization of environmental health data through information and technology transfer with other government agencies, private groups and organizations and the public.

Thank you, Mr. Chairman, and I would be happy to answer any questions.

[The prepared statement of Dr. Sexton follows:]

TESTIMONY OF
KEN SEXTON, SC.D.
DIRECTOR, OFFICE OF HEALTH RESEARCH
OFFICE OF RESEARCH AND DEVELOPMENT
U.S. ENVIRONMENTAL PROTECTION AGENCY
BEFORE THE
SUBCOMMITTEE ON NATURAL RESOURCES, AGRICULTURAL
RESEARCH, AND ENVIRONMENT
COMMITTEE ON SCIENCE, SPACE AND TECHNOLOGY
HOUSE OF REPRESENTATIVES

APRIL 6, 1988

Good afternoon Mr. Chairman and members of the subcommittee. Thank you for the opportunity to provide you with my perspective on emerging and future trends in environmental health.

The field of environmental health has progressed rapidly over the past 20 years or so and has contributed greatly to our awareness and understanding of the link between environmental contaminants and human health. Since about 1970, our expanding knowledge of sources, ambient concentrations, environmental exposures, and human health effects has led to enactment of important environmental laws that are aimed at protecting public health, such as the Clean Air Act, the Safe Drinking Water Act, and the Resource Conservation and Recovery Act. The U.S. Environmental Protection Agency (EPA) is responsible not only for implementing the Federal environmental statutes, but also for supporting and carrying out research to improve regulatory decisions.

The EPA health research program is mission oriented and necessarily spans the gamut from basic to applied. It falls

mainly into four general areas: 1) development of better methods for characterization of health risk, primarily through application of improved statistical models; 2) development, improvement, and validation of test methods for use by others; 3) generation of dose-response data for specific environmental agents; and 4) improvement of the Agency's ability to perform health risk assessments. The program encompasses all types of environmental health research, including in vitro and in vivo animal experiments, human studies using in vitro, clinical, and epidemiologic approaches, and investigation of structure-activity relationships.

With the start of the 21st century only 12 years away, this is an appropriate time to take stock of the field and to examine, as best we can, the nature of environmental health issues that are likely to confront us in the next century. Unfortunately, it is always easier to chronicle the past or document the present than it is to anticipate the future. Nevertheless, it is clear that some environmental health issues and trends are likely to continue to have significant ramifications well into the 21st century.

One important trend that we can be sure will have significant implications for the field of environmental health is our ever expanding ability to detect subtle health effects and to establish their causal association, or lack thereof, with chronic, low level exposures to environmental

agents. Just as the state-of-the-art in environmental monitoring has progressed so that it is now possible to measure pollutant concentrations at the part-per-trillion level, so too will our capabilities to detect subtle health effects continue to be enhanced over the coming years. As our understanding of the basic biological mechanisms that underlie both cancer and non-cancer effects improves, our ability to perform quantitative health risk assessments will also improve. This in turn will help us make better decisions about the protection of public health.

Because the EPA is responsible for interpreting the available data and for applying those data to regulatory decisions, advances in the state-of-the-science often raise questions, as well as present opportunities. For example, our enhanced ability to measure subtle biological changes challenges us to interpret those changes in terms of their relationship to injury or illness. The difficult question is: "When should a measurable biological effect be considered an adverse health effect?" This is a critical question for the Agency as we move into the 21st century.

Among the key issues that are most likely to have an impact on environmental policy and research planning into the 21st century are:

- o Non-Cancer Health Effects - It is now clear that there are often a variety of health outcomes that may arise from an environmental insult. This

realization has focused increased attention on the need to obtain appropriate data on non-cancer health effects. It is often unclear, for example, which health endpoints are important, for which agents, and in what kinds of situations.

Improvements in our ability to make reliable estimates of non cancer health risks will aid in making informed judgments about protection of public health.

- o Molecular Epidemiology - The possibility of using biological indicators to link individual exposure with health outcome is rapidly becoming a reality. The use of these techniques within the context of epidemiologic investigations offers a means to more directly assess health risks, and thereby reduce the uncertainties associated with risk estimates.
- o Complex Mixtures - Environmental exposures typically occur not to a single pollutant, but to a complex mixture. Research to determine which components are most toxic, mutagenic, or carcinogenic and to assess whether health risks are additive for the individual components of the mixture will continue into the foreseeable future. The results of this research could have important implications for the way we address problems such

as urban air pollution and drinking water disinfection.

- o High Risk Groups - Our ability to identify population subgroups who are at increased risk as compared to the general population is steadily improving. Advances in our understanding of biological predisposition to a particular health effect (e.g., genetic susceptibility) and in our knowledge of human activity patterns that give rise to elevated exposures will continue to help us focus the Agency's research and regulatory efforts on the appropriate groups.
- o Hazard Identification - It is critical to determine in a timely manner whether there is a causal relationship between an environmental factor and an adverse health outcome. Currently, there are several issues and/or technologies for which the hazard identification process is ongoing, both inside and outside the Agency:
 - 1) human exposure to non ionizing radiation (particularly Extremely Low Frequency radiation inside residences);
 - 2) chemicals used in the microelectronics industry;
 - 3) methanol used as an alternative fuel in motor vehicles; and

4) environmental release of genetically engineered microorganisms.

Both research and regulatory decisions will be affected by the outcome of these evaluation activities.

In summary, the EPA maintains an active involvement and interest in non-cancer health effects, molecular epidemiology, complex mixtures, high risk groups, and hazard identification, through its health research program. The Agency is committed not only to improvement in the quality and quantity of the available data, but also to the appropriate interpretation and the proper application of those data to decisions about protecting public health. In addition, the EPA is dedicated to better utilization of environmental health data through information and technology transfer with other government agencies, private groups and organizations, and the public.

Thank you, Mr. Chairman, that concludes my prepared statement. At this time I would be happy to answer any questions that you might have.

Mr. VALENTINE. Thank you, sir.
Mr. Fishbein.

STATEMENT OF GERSHON W. FISHBEIN, ENVIRONMENTAL HEALTH LETTER

Mr. FISHBEIN. Mr. Chairman and members of the Subcommittee, it is a great honor to be allowed the opportunity to testify before your Subcommittee today. Not every reporter has the privilege of making the transition from the press table to the witness table, and I must therefore acknowledge at the outset my indebtedness to you for making this possible in my case.

I began publishing Environmental Health Letter in October 1961 during the first year of President Kennedy's term. At that time, ten years before the creation of the EPA, the environment was in the custody of the U.S. Public Health Service at the federal level and in health departments at the state level. In retrospect, it seems difficult to believe, but the Bureau of Environmental Health in the U.S. Public Health Service in the 1960's had 11 divisions, each concerned with a different program. In addition to the traditional air and water pollution programs, divisions were concerned with such matters as metropolitan planning, urban rodent control programs, community lead control programs, basic sanitation in restaurants and on trains, planes and other interstate carriers.

It goes without saying that environmental health was defined much more broadly in those days than today. It was subsequently determined by the Nixon Administration that the federal government had no business telling local communities how to control rats. Therefore, the program was eliminated. One by one, other community-based programs in the environment were also disbanded. It was believed that the communities themselves would take over the programs, but even with federal technical assistance it soon became evident that the communities lost interest because of competing claims on the dwindling financial resources of many localities.

When EPA was created in 1971, amid the euphoria of the upcoming Earth Day, it was hoped that the environmental movement which was nurtured on many campuses as a counterweight to the Vietnam War, would find a home and a rallying point in the federal government. To a great extent, it did.

But as one reporter who covers environmental health, I regret that the health component did not share in the national passion for cleaning up the environment. We sought to save redwoods but saw little connection between air pollution and pulmonary disease until it was too late to be prevented. Such large national organizations as the Sierra Club, Izaak Walton League, National Wildlife Federation and National Audubon Society, to name just a few, did not include public health in their agendas until the effects of toxic chemicals became matters of national priority.

We have spent much of the last decade building up a substantial and significant data base on environmental hazards, but we are not doing that much more about them. Health, which used to be the centerpiece of environmental programs, is today relegated to the sub-basement in the organizational structure and consciousness of

EPA. In domino fashion, more than three-fourths of the states have shifted environmental responsibilities from health agencies to departments of ecology or natural resources to reflect the new priorities.

I must say that one shining exception to what I consider a national lassitude about environmental health is to be found in the tremendous growth of NIEHS here in Research Triangle Park. It stands as a formidable example of how investments in a basic understanding of the effects of environmental contaminants on man's health can pay off.

One can only wish that such progress was matched by EPA in its regulation, although I have no quarrel really with its research, which I realize is the primary concern of this Subcommittee. And again, I am speaking only of the health component. I do not deny that Superfund has many health connotations, but at its root it is a public works rather than a public health program, and it is this program which drives nearly all others at the agency.

Environmental health lacks a national constituency. The American Public Health Association, which normally would be in the forefront of such a movement, is hobbled by financial problems and its role in direct intervention has been more limited than many had hoped. Schools of medicine and public health have generally not rallied to the cause of environmental health. Environmental faculty gets scant recognition and its practitioners are seen as way out of the medical mainstream.

I wish, through my newsletter, that I could chart a course out of the woods as we move closer to the 21st Century. One aspect merits attention. I firmly believe that if we are going to make a move on environmental health controls, we must do it on a regional rather than a state basis. The fiction that air and water pollution can be regulated at state borders reflects, in my view, the political process that elects members of Congress from states. Not enough of our environmental legislation encourages the formation of regional compacts on a continuing basis.

Mr. Chairman, those are just some random observations from one who has been privileged to be a close spectator of the peaks and valleys of the environmental landscape for more than 25 years. They offer no new insights and, perhaps worse from a journalist's vantage point, are hardly news. Yet, as we start the baseball season, I can only say that I try to call them as I see them.

Thank you, Mr. Chairman, I will be glad to reply to any questions you or other members might have.

[The prepared statement of Mr. Fishbein follows:]

Environmental Health Letter
Occupational Health & Safety Letter
Genetic Engineering Letter

952 National Press Building / Washington, D.C. 20045 / (202) 662-7290

ENVIRONNEWS, INC.

Gershon W. Fishbein, Publisher

Testimony of Gershon W. Fishbein
Publisher, Environmental Health Letter

To Subcommittee on Natural Resources, Agriculture Research and Environment
U.S. House of Representatives
Research Triangle Park, NC, April 6, 1988

Mr. Chairman and members of the subcommittee:

It is a great honor to be allowed the opportunity to testify before your subcommittee today. Not every reporter has the privilege of making the transition from the press table to the witness table, and I must therefore acknowledge at the outset my indebtedness to you for making this possible in my case.

I began publishing Environmental Health Letter in October 1961 during the first year of President Kennedy's term. At that time the environment was in the custody of the U.S. Public Health Service at the federal level and in health departments at the state level. In retrospect, it seems difficult to believe, but the Bureau of Environmental Health in the U.S. Public Health Service in the 1960s had 11 divisions, each concerned with a different program. In addition to the traditional air and water pollution programs, divisions were concerned with such matters as metropolitan planning, urban rodent control programs, community lead control programs, basic sanitation, etc.

It goes without saying that environmental health was defined much more broadly in those days than today. It was subsequently determined by the Nixon Administration that the federal government had no business telling local communities how to control rats. Therefore, the program was eliminated. One by one, other community-based programs were also disbanded. It was believed that the communities themselves would take over the programs, but even with federal technical assistance it soon became evident that the communities lost interest because of competing claims on the dwindling financial resources of many localities.

When EPA was created in 1971, amid the euphoria of Earth Day, it was hoped that

-2-

that the environmental movement, which was nurtured on many campuses as a counter-weight to the Vietnam war, would find a home and a rallying point in the federal government. To a great extent, it did.

But as one reporter who covers environmental health, I regret that the health component did not share in the national passion for cleaning up the environment. We sought to save redwoods but saw little connection between air pollution and pulmonary disease. Such large national organizations as the Sierra Club, Izaak Walton League, National Wildlife Federation and National Audubon Society, to name just a few, did not include public health in their agendas until the effects of toxic chemicals became matters of national priority.

We have spent much of the last decade building up a substantial and significant data base on environmental hazards, but we're not doing that much more about them. Health, which used to be the centerpiece of environmental programs, is today relegated to the sub-basement in the organizational structure and consciousness of EPA. In domino fashion, more than three-fourths of the states have shifted environmental responsibilities from health agencies to departments of ecology or natural resources to reflect the new priorities.

I must say there that one shining exception to what I consider a national lassitude about environmental health is to be found in the tremendous growth of NIEHS here in Research Triangle Park. It stands as a formidable example of how investments in a basic understanding of the effects of environmental contaminants on man's health can pay off.

One can only wish that such progress was matched by EPA — and again I am speaking only of the health component. I do not deny that Superfund has many health connotations, but at its root it is a public works rather than a public health program, and it is this program which drives nearly all others at the agency.

Environmental health lacks a national constituency. The American Public Health Association, which normally would be in the forefront of such a movement, is hobbled by financial problems and its role in direct intervention has been more limited than

-3-

many had hoped. Schools of medicine and public health have generally not rallied to the cause of environmental health. Environmental faculty gets scant recognition, and its practitioners are seen as way out of the medical mainstream.

I wish, through my newsletter, that I could chart a course out of the woods as we move closer to the 21st century. One aspect merits attention. I firmly believe that if we are going to make a move on environmental health controls, we must do it on a regional rather than a state basis. The fiction that air and water pollution can be regulated at state borders reflects, in my view, the political process that elects members of Congress from states. Not enough of our environmental legislation encourages the formation of regional compacts on a continuing basis.

Mr. Chairman, those are just some random observations from one who has been privileged to be a close spectator of the peaks and valleys of the environmental landscape for more than 25 years. They offer no new insights and, perhaps worse from a journalist's vantage point, are hardly news. Yet, as we start the baseball season, I can only say that I try to call 'em as I see 'em.

Thank you, Mr. Chairman. I will be glad to reply to any questions you or other members may have.

Mr. VALENTINE. Thank you, sir.
Dr. Goldstein.

STATEMENT OF DR. BERNARD D. GOLDSTEIN, UMDNJ-ROBERT WOOD JOHNSON MEDICAL SCHOOL, DEPARTMENT OF ENVIRONMENTAL AND COMMUNITY MEDICINE

Dr. GOLDSTEIN. Mr. Chairman, Mr. Price, thank you for the opportunity to testify. I appreciate also the opportunity of paraphrasing my written submission.

The topic of environmental health in the 21st Century is obviously an important one. If we are to continue to anticipate increases in life expectancy and, of perhaps greater importance, increases in the health status of our population so that life can be more fully productive and enjoyable, it is imperative that we rigorously attack the environmental causes of disease.

What follows in this enormous topic is a somewhat idiosyncratic approach that I have taken to highlight certain of these issues. Let me start by pointing out that as a simplification, new challenges in a health field can come in two ways. They can come by advances in understanding existing diseases or causes, or by the emergence of new diseases or causes. I suspect in the 21st Century we will see both.

Many very important diseases are caused by factors that we do not understand. For some we can speak eloquently about various points in the long process leading to the disease, and we have sufficient information to devise treatments, sometimes with dramatic effect. However, we often do not know what initiates the disease and are therefore powerless to prevent it; nor what—we often do not know what environmental factors alter disease outcome in ways that impact greatly on pain and suffering. For example, there is much understanding of the development and treatment of rheumatic diseases, particularly rheumatoid arthritis and to some extent lupus. However, despite the fact that we know that certain therapeutic drugs can cause lupus, we really know little about what causes these rheumatic diseases in general, nor what factors contribute to the periodic waxing and waning of symptoms and disability that occurs among people who have rheumatoid arthritis and these other diseases. I predict that environmental factors will be found to play a role in instigating and exacerbating these diseases, and that recognition of these environmental factors will lead to prevention of at least some of the death and disability caused by these diseases.

Now I chose the example of rheumatic diseases for this prognostication because it is an important human disease category for which we are only beginning to develop the basic research tools necessary to ask the pertinent questions. In particular, we need to know more about the interaction between environmental factors and heredity to be able to respond to this challenge. There are many other existing disease categories for which the link with environmental factors is more evident. We can easily cite the 85% of human cancer that is due primarily to non-hereditary factors.

There are also new environmental health problems which we can anticipate. New technology inevitably brings new health risks, and

we have heard much of that in the past two days. Our recent problems detected in the so-called clean electronics industry are very notable in this regard. New technology will not only bring new problems, it may exacerbate existing problems to the point that they become recognizable. One of the more intriguing areas is that of the various non-ionizing radiation frequencies, magnetic frequencies. We can expect newer frequency ranges, mixtures of ranges and higher intensities as different technologies develop, particularly based on super-conduction, as we have heard today, and other means to improve the efficiency of use of our physical universe. Whether they will produce adverse health effects is unclear. However, it is clear that if we do not develop the basic understanding needed to make predictions, we will either have unforeseen adverse aspects to these technologies or we will unnecessarily restrict societally useful technical advances.

There are a number of special challenges we will face as our society changes. The aging of the American population will bring renewed emphasis on understanding the determinants of the decline in function that occurs with aging. Repetitive subtle environmental exposures will undoubtedly play a role. It is imperative that we develop the basic science insights into the underlying causes of loss of function and disability in the healthy aged, and work to develop preventive approaches for these causative factors that are environmentally determined.

We can also anticipate that there will be an increasing challenge to communicate to the public about environmental risk. It is certainly a challenge that occurs now and that we really have not met well. Improvements in analytical chemistry will accelerate the vanishing zero phenomenon in which environmental media—air, water—previously thought to be pristine are now found to have parts per quadrillion or quintillion of a hazardous substance because we can now measure those low levels. Improvements in scientific understanding will lead to better communication, in part because we will be able to address the problems with greater certainty, but also in part because we will be able to readily demonstrate the potential hazard to the public. An example of the latter is the current situation with radon. The public has been slow to respond to warnings of this real environmental health hazard despite many efforts to communicate to the public. Imagine instead of just supplying a kit to a homeowner to measure airborne radon levels, we were able to develop a device to simply and effectively measure radioactive radon products in the lungs of children. This would be a very valuable research tool, but it would also be an effective means of galvanizing a family to take appropriate remedial action.

A number of the expected major advances in environmental health science can be grouped under the heading of biomarkers. These are indicators of exposure, of effect or of susceptibility which can be measured in biological fluids. Advances in molecular biology coupled with advances in the science of toxicology and which to a large extent have been supported by NIEHS, provide many opportunities for breakthroughs in our ability to deal with environmental health hazards. By measuring miniscule amounts of environmental chemicals attached to protein or genetic material in blood, we should be able to far more accurately quantitate environmental

exposure and predict the adverse consequences, including determinations of low level risks not now approachable by conventional epidemiological or animal studies. Markers of susceptibility will allow determination of those individuals particularly at risk from chemicals in the workplace or general environment. As Dr. Rall has stated, such markers will raise ethical issues which we need to start addressing now.

It is a truism that as we continue to better understand the development of disease, we will better recognize the environmental factors involved in disease causation. Further, there is every reason to expect that understanding such environmental causes will lead to the desired goal of prevention of disease. The key point is understanding. This can only reasonably be expected if we perform the basic research that will permit the insights necessary to link environmental exposures to disease processes.

Let me close by pointing out that there is only one prediction about environmental health in the 21st Century that I can make with absolute certainty. That is that there will be an environmental health problem that none of us will now predict. For this reason, it is imperative that the field of environmental health research be a dynamic one, alert to problems as they develop, and able to respond rapidly and flexibly to protect public health.

Thank you.

[The prepared statement of Dr. Goldstein follows:]

TESTIMONY

**SUBCOMMITTEE ON NATURAL RESOURCES, AGRICULTURE
RESEARCH, AND ENVIRONMENT**

ENVIRONMENTAL HEALTH IN THE 21ST CENTURY

**Bernard D. Goldstein, M.D.
Director
Environmental and Occupational Health Sciences Institute
University of Medicine and Dentistry of New Jersey, and
Rutgers, The State University of New Jersey
675 Hoes Lane
Piscataway, NJ 08854**

April 6, 1988

Thank you for the opportunity to testify on the topic of Environmental Health in the 21st Century. This is an important subject. If we are to continue to anticipate increases in life expectancy and, of perhaps greater importance, increases in the health status of our population so that life can be more fully productive and enjoyable, it is imperative that we rigorously attack the environmental causes of disease.

Governor Tom Kean has given the mandate of anticipating environmental health problems to our new Environmental and Occupational Health Sciences Institute, a joint program of Rutgers, The State University of New Jersey and the University of Medicine and Dentistry of New Jersey. Our faculty has been actively considering this enormous topic. Based on this effort I have prepared the following somewhat idiosyncratic approach to highlight certain of these issues.

As a simplification, new challenges in a health field can come in two ways: advances in understanding existing diseases or causes, and the emergence of new diseases or causes. Both will occur in the 21st century.

New Understanding of Existing Disease

Many very important diseases are caused by factors that we do not understand. For some we can speak eloquently about various points in the long process leading to the disease, and we have sufficient information to devise treatments, sometimes with dramatic effect. However, we often do not know what initiates the disease, and are therefore powerless to prevent it; nor what environmental factors alter disease outcome in ways that impact greatly on pain and suffering. For example, there is much understanding of the pathogenesis and

treatment of rheumatic diseases, such as rheumatoid arthritis and systemic lupus erythematosus. However, despite the fact that we know that certain therapeutic drugs can cause lupus, we really know little about what causes these rheumatic diseases in the general population, nor what factors contribute to the periodic waxing and waning of symptoms and disability. I confidently predict that environmental factors will be found to play a role in instigating and exacerbating these diseases; and that recognition of these environmental factors will lead to prevention of at least some of the death and disability caused by these diseases.

I chose the example of rheumatic diseases for this prognostication into environmental health in the 21st century because it is an important human disease category for which we are only beginning to develop the basic research tools to ask the pertinent questions. There are many other existing disease categories for which the link with environmental factors is more evident. The 85% of human cancer due primarily to non-hereditary factors is an obvious example.

New Environmental Health Problems

New technology inevitably breeds new health risks. We need to look no further than the recent problems detected in the so-called clean electronic industry to recognize this fact. New technology will not only bring new problems, but may exacerbate existing problems to the point of recognition. One of the more intriguing areas is that of the various non-ionizing radiation frequencies. We can expect newer frequency ranges, mixtures of ranges, and higher intensities as different technologies develop, particularly based on superconduction and other means to improve the efficiency of use of our physical universe. Whether they will produce adverse health effects is unclear. However,

it is clear that if we do not develop the basic understanding needed to make predictions we will either have unforeseen adverse aspects or we will unnecessarily restrict a societally useful technical advance.

Special Challenges

There are a number of special challenges we will face as our society changes. The aging of the American population, particularly as the baby boomers pass retirement age, will bring renewed emphasis on understanding the determinants of the decline in function that occurs with aging. Repetitive subtle environmental exposures will undoubtedly play a role. It is imperative that we develop the basic science insights into the underlying causes of loss of function and disability in the "healthy" aged, and work to develop preventive approaches for those causative factors that are environmentally determined.

We can also anticipate that there will be an increasing challenge to communicate to the public about environmental risk. Improvements in analytical chemistry will accelerate the "vanishing zero" phenomenon in which environmental media previously thought to be pristine are now found to have parts per quadrillion or quintillion of a hazardous substance because we can now measure these low levels. Improvements in scientific understanding will lead to better communication, in part because we will be able to address problems with greater certainty, and in part because we will be able to more readily demonstrate the potential hazard to the public. As an example of the latter, consider the radon problem. The public has been slow to respond to warnings despite many efforts to communicate about this serious environmental health hazard. Imagine instead of just supplying a kit to measure airborne radon levels at home we were able to

develop a device to simply and effectively measure radioactive radon products in the lungs of children. Such a device would be a valuable research tool but would also be an effective means of galvanizing a family to take remedial action.

Biological Markers

A number of the expected major advances in environmental health science can be grouped under the heading of biomarkers. These are indicators of exposure, effect or susceptibility which can be measured in biological fluids. Advances in molecular biology coupled with advances in the science of toxicology provide many opportunities for breakthroughs in our ability to deal with environmental health hazards. By measuring minuscule amounts of environmental chemicals attached to protein or genetic material in blood we should be able to far more accurately quantitate environmental exposure and predict adverse consequences, including determination of risk at the lower end of the dose response curve not now approachable by conventional epidemiological or animal bioassay techniques. Markers of susceptibility will allow determination of those individuals particularly at risk from chemicals in the workplace or general environment. Such markers will raise ethical issues of societal importance that we should begin to address in the near future.

Conclusion

It is a truism that as we continue to better understand the development of disease we will better recognize the environmental factors involved in disease causation. Further, there is every reason to expect that understanding such environmental causes will lead to the desired goal of prevention of disease. The key point is understanding. This can only reasonably be expected if we perform

the basic research than will permit the insights necessary to link environmental exposure to disease processes.

Let me close by pointing out that there is only one prediction about environmental health in the 21st century that I can make with absolute certainty. There will be an environmental health problem that none of us now predict. For this reason it is imperative that the field of environmental health research be a dynamic one, alert to problems as they develop, and able to respond rapidly to protect public health.

Mr. VALENTINE. Thank you, Doctor. Thank all of you.

I have a question or two which I would like to direct to the panel, anybody who wants—who has an answer or wants to take a swing at it. And then I want to of course yield to my colleague, Mr. Price. We would hope to be able to conclude these proceedings around 4:00 but I want to leave time for each member of the panel to give any additional information that might have occurred to you following the presentation of your colleagues, and add anything, make any other statements that you think might be helpful to us. And this is your opportunity to cross-examine members of the press. I do not know if he has written anything unfavorable about any of you, but now is your chance to give him hell. [Laughter.]

Many Americans, many people in our country, understandably so, have become increasingly distrustful of new technologies. I do not know, a layman might call it a Pandora's box syndrome. You know, nuclear energy, nuclear power is the obvious example; food processing techniques; microwaves; electromagnetic frequencies and so on. In other words, thinking people who are not of a scientific bent, a lot of people like me who had problems with freshman chemistry in college, are concerned about these things, and for good reason. Many folks believe we have done a poor job in predicting—by we, I mean all of us and especially those responsible with enacting statutes—we have done a poor job in predicting and evaluating potential environmental problems.

In Congress, as several of you have pointed out, we frequently find ourselves in a position of reacting to a crisis.

I want to ask you what kind of research, in the opinion of the panel, is needed to provide an early warning system, if that is the way to put it, and how can we go about setting priorities if we cannot study everything.

Dr. Silbergeld.

Dr. SILBERGELD. Thank you, Mr. Chairman. I think there are two things we can do, and one I think is fairly practical. Congress, the federal government, the private sector frequently makes fairly well publicized investments or easements or other types of—takes other kinds of actions to encourage specific technologies. We can certainly examine super-conductivity as an example. It is pretty clear, I think, that there is a large scale federal and private sector investment going on in this technology. It would not, in my opinion, be unreasonable for Congress at the same time to direct Dr. Rall to institute a very targeted research program designed to provide complementary tandem research—state-of-the-art research information, which would aid in the prediction and ascertainment of any possible toxic consequences of the exploitation of these extremely exciting developments in physics. I do not think it takes much of a crystal ball to do that kind of examination of the research budgets of the Department of Defense, Department of Energy, Department of Agriculture, and other technology nurturing organizations in the public and private—and increasingly the combined public/private, university/private sectors, to make sure that we do have the specifically directed research that we are going to need.

The other answer to your question I think is very simply surveillance. The only way we are going to detect whether things are hap-

pening is to pay attention to them. This country I think has the unenviable position at the bottom of the heap of advanced societies in the amount of health and hazard surveillance that we conduct. We really collect very little in the way of health statistics and we have very poor information in terms of the distribution of potentially toxic exposures throughout the country. EPA, for example, jettisoned its national human adipose tissue survey, which was one of the very few surveillance systems we had that would allow us to answer with any precision just what kinds of exposure is going on out there. Are they changing, are there trends, are there things we should be worrying about. We almost got rid of one of the very few programs in that area we have—we need much more of them.

Mr. VALENTINE. Thank you, Doctor.

Dr. Rall.

Dr. RALL. I would be delighted to make a few comments in this area. We have sporadically at our institute had, and have always had the concept of, a technological surveillance group whose job it is to do its best to follow the new technology, the new chemistry and so forth, and ask the question are there any particular possible problems associated with this. It is do-able to some extent, but as Dr. Goldstein said, we will not always exceed. There is a wonderful expression that the engineer should think about, no tank never leaks—and no prediction system is perfect.

I would suggest—

Mr. VALENTINE. Is that tank or roof?

Dr. RALL. Believe me, I know the latter very well indeed. [Laughter.]

We have been concerned about pesticides in the groundwater and lead in our drinking water for years. The problem has been to get the evidence that links the chemical presence in that media with adverse human health effects. And one of the important things that was discussed yesterday was the new methods of looking at kids' intellectual development and their neurological development, and linking that to either their blood lead level, their mother's blood lead level or the level of lead in their teeth. And just in the last few years we were able to show some research which we supported and other NIH institutes supported, that lead is very toxic to the newborn child, perhaps twice as toxic as we had previously thought. We always had that suspicion but we could not prove it. But new methodology let us prove it.

So in essence, what we need is better technology, just as Bernie Goldstein was talking about. We need to be able to look at DNA and say that has been—there has been interaction between that and environmental chemicals. We have wonderful new methods that we are developing for magnetic resonance imaging which will let us look at a mouse or a rat and say—without doing anything to the animal, keeping it alive—saying that animal has a liver tumor this big (indicating) or in fact in a rat you can detect a pituitary tumor about a 30th of an inch in diameter.

So our technology is moving along. We need all the help we can get, but I think we are making better progress than it may seem to you who are on the firing line.

Mr. VALENTINE. Dr. Miller.

Dr. MILLER. Just a couple of comments, Mr. Chairman. Let me say first of all that the monitoring issue is one which I totally agree is an area that requires substantial continual investment. The problem is that under current budgetary situations, it is very difficult to maintain any rational monitoring. A lot of the monitoring that gets done is token, simply in order to keep an eye on what is going. And the reason for it is quite simple. The FDA has its market basket survey in which it does nearly 300 different chemical substances and over 250 foods four times a year. Each one of those markets represents something in the order of magnitude of 75 to 100,000 different analyses. So these are very expensive propositions and if one is going to do a monitoring program, you have got to know and be prepared to carry this through. You cannot do it for awhile when it is hot, and then decide you do not want to do it later on. That is a waste of money, you might as well not do it at all.

But I agree with Dr. Silbergeld absolutely that we need at least to be considered and perhaps it ought to be part of the cost of doing business. I think it ought to be part of the cost of any new substance or new technique introduced into the environment, particularly in the food supply. Part of that ought to be—one of the requirements ought to be a monitoring of those materials for a period of time, monitoring of people who consume products that contain these things as well as what happens to it when it gets out into the environment.

FDA did this with some substances like aspartame. The agencies made a requirement for the producers to keep an eye on what was going on.

Another area, however, I must emphasize again is that we need to continue and must expand our work in the basic science of toxicology. One of the problems, as I said earlier at this meeting, is you do not know what you do not know. And if you cannot ask questions, you are just going to do what you have done in the past. The problems we face very often are those which appear to arise out of the blue, we never knew they would occur, and yet appropriate research on the way in which substances interact with an organism can often give you clues not only on where to look but perhaps more importantly can help develop technologies which might make the monitoring situation much more reasonable.

And finally, let me make a plea that we also have to start considering the biological component of the environment; that is, the microorganisms of the environment, particularly in terms of the food supply. When we talk about environmental science, we invariably talk about the chemical contamination in foods, but by far the most immediate problem that we are facing today is the increasing rate of food borne pathogens, food borne pathogenic illnesses that are being transmitted to the public. These are occurring because of newly identified organisms, because old ones are transformed—no one really understands why in spite of everything we have done, the rate keeps going up rather than coming down. Yet that is part of the environment, it is part of the interaction that makes the environment safe or unsafe.

Mr. Chairman, I wonder if I might be excused, since an airplane calls, which I would like to get on before the storm hits.

Mr. VALENTINE. Yes, of course, Doctor. Do you have any objection if we let Dr. Miller go?

Mr. PRICE. Please go catch your airplane, the storm is indeed coming.

Dr. MILLER. Thank you very much.

Mr. VALENTINE. Thank you so much, Doctor.

Dr. Sexton.

Dr. SEXTON. I think the issue of setting priorities is the key, and what we are finding is as we have heard over the last couple of days, many of our old problems continue. They do not go away. So we are increasingly faced with an expanding burden. We have the old problems and as we learn more about them, some are more serious than we thought, and we are faced with potential new problems. It presents sort of the classical dilemma to us in environmental health sciences—where do you put your resources. You clearly have problems and issues that you know a lot about, lead or ozone might be examples, where more research needs to be done. At the same time, we have emerging technologies where there is a potential for health risk. These are the kinds of questions that are extremely difficult to answer and I think one of the ways to begin to approach that is through a symposia or a meeting like Dr. Rall has put on for the last couple of days. One of the things we try to do is to get together outside qualified scientists and talk about these issues and basically brainstorm and hope to reach a consensus.

Some of the things that the agency has done and continues to do in the interim; there has to be some screening process for chemicals, for processes and indeed we continue to work towards and I think it is a goal that is probably a long way off, that some sort of screening technology will help us. We work a lot looking at the structure of chemicals to see if we can predict based on their structure what their biological effect might be. We have come a long way, but we have a long way to go, including this short term test where we try to do some very quick, short tests that can allow us to screen out some of the worst actors, and to concentrate our resources on those.

Those are the kinds of things at least we are doing right now.

Mr. VALENTINE. Thank you.

Mr. Goldstein.

Dr. GOLDSTEIN. Congressman, if I could venture to say that perhaps because of the fire fighting responsibilities that you have and the agencies have, we very often do not recognize the fact that we have had a fair amount of success. It is difficult to quantify this success.

I teach preventive medicine to medical students. It is difficult to do that for the same reason. If you have a student with a physician and the physician is taking care of someone who is sick and the physician gives a drug and the person gets better, that is easily understood and remembered. If the physician says stop smoking, stop doing something, and the person because of that ten years later does not come down with cancer, does not get a stroke, if they take care of the high blood pressure, the student does not have that feedback, does not recognize that as occurring.

I think the same thing has happened in a lot of our environmental health problems in that we have not had problems because of

the kind of work that has been done by scientists and that has been put into law by Congress; something like the Toxic Substance Control Act, a lot of the Food and Drug Administration Acts, basically have meant that industry does some screening tests on a new chemical they might want to use, if it fails some of these screening tests because the screening test sort of suggests that we have a compound that may produce some adverse effect, they stop development right then and there. There is no sense their proceeding on that. So we have not seen problems that we would have seen had we not had the basic science and the legislation that has prevented those problems. But how does one quantify that, particularly if one is faced with fighting fires and the public outcry for those problems that we do have left.

I would submit we need to pay attention to the preventive mode rather than just cleaning out the dirt that we do have in our environment.

Mr. VALENTINE. Thank you, Doctor.

Mr. Price.

Mr. PRICE. Thank you, Mr. Chairman.

Dr. Sexton, I wonder if you could give us some budget information about the portion of the EPA budget that is devoted to health research and also what the trends have been over the last number of years in budgeting for this purpose.

Dr. SEXTON. Yes, sir, I can try. The trends over the last several years, say three or four years, in the total amount of money that has gone to the health research side have been relatively stable or perhaps show a slightly downward trend. For the Office of Research and Development, where the research funds are, where my office is, our budget this year I think was about \$52 million, that included the extramural and intermural component as well. I am not sure how much more detail you would like to hear.

Mr. PRICE. Well I am interested in how you would respond to some of Dr. Silbergeld's assertions in particular about the limitations of EPA in this regard, the kind of limits that you have been operating under. I wonder if you could give us some sense of what the competing budget priorities have been, what you could have used more money for, exactly the extent to which your operation you feel, the kind of things EPA might be doing in this health area in particular, have been adequately underwritten.

Dr. SEXTON. The agency is tasked with a large responsibility and one we take very seriously. There are I think nine major environmental laws if I recall, having differing statutes that we have to enforce. And the research program is designed to help us make better regulatory decisions. In terms of priorities, it is sometimes a difficult call, given that there are finite resources—I think we understand that—some of the decisions that we have had to make have been based on our best judgment in terms of the kinds of issues that we should be addressing.

I think, for instance, Dr. Silbergeld brought up the issue of manganese. I think there is a good point there and indeed we are looking at that issue in the sense that manganese, the chemical that may possibly be introduced into the automotive fleet, may have some similarities to the lead issue and we need to take a look at that and make sure that we do not make similar mistakes. Indeed,

the forward-looking kinds of things that I think everyone here would support, the agency is doing its best to try to take a look at the future and as best we can align our research program to those future needs.

Mr. PRICE. The \$52 million figure that you use, exactly what does that refer to?

Dr. SEXTON. That actually is both our extramural budget, what we call our research and development budget, and the salary and expenses budget for the EPA employees, travel, equipment, things like that.

Mr. PRICE. And that covers the Office of Health Research?

Dr. SEXTON. Yes, sir.

Mr. PRICE. And it is not the overall Office of Research and Development, that is your Office of Health Research?

Dr. SEXTON. It is—the Office of Research and Development is a larger organization and the Office of Health Research is one of seven offices in that.

Mr. PRICE. How does that funding compare let us say with the funding for fiscal year 1980?

Dr. SEXTON. I could not off the top of my head say. There was a change in the funding, I think there was a decrease around 1980, as I recall, but I would have to get that information for you.

Mr. PRICE. All right. We would like that information for the record, if you would furnish it, and perhaps a time line indicating what the budget allocations have been over this eight year period.

Dr. Silbergeld.

Dr. SILBERGELD. I think it would be remiss of me not to make two comments on this. One is it seems very odd to characterize as forward-looking research into a compound after its use has been approved. And that is just guaranteed to repeat the history of lead, not to get in front of a problem. Why EPA approved this use of manganese before they had instituted any research is something that is yet to be answered.

Mr. PRICE. Well let us just stop right there. Exactly what has been done with respect to the approval of manganese for the uses cited?

Dr. SEXTON. I am actually not familiar with what has been approved. That is outside of my knowledge. But in terms of what the agency did, we, through the Health Effects Institute—

Mr. PRICE. Now just a moment, who does the approving? Exactly whose responsibility are we talking about?

Dr. SEXTON. We are talking here about a regulatory office within the agency, the Office of Mobile Sources.

Mr. PRICE. And you have no knowledge of what that office has done in this particular instance?

Dr. SEXTON. I was not aware that they had approved the manganese issue.

Mr. PRICE. Dr. Goldstein, do you have information on that, or Dr. Silbergeld?

Dr. GOLDSTEIN. No, I do not, that has happened since I left the agency.

Mr. PRICE. Well we certainly need that information for the record, and I am disappointed that you do not have it.

Dr. Silbergeld.

Dr. SILBERGELD. I will be glad to supply to the Committee correspondence that we have obtained within EPA and between EPA and Volkswagen of America, granting this approval prior to any consultation with the Health Effects Institute, which in my opinion was purely token and again after the fact, and also prior to any contemplation or undertaking of in-house or externally supported research on this subject.

[Material not supplied.]

Mr. PRICE. Explain if you will your point about the Health Effects Institute. Exactly what is that?

Dr. SILBERGELD. The Health Effects Institute very briefly is a hybrid organization supported by EPA and by the automotive industry. Its goal is to enable the agency to have at its disposal critical information related to potential health and environmental impacts, specifically under those that might arise from the introduction of toxins through mobile sources such as vehicles, into the air.

Mr. PRICE. And what is your point about the role of this Institution played or the role they sought to play? What exactly is the situation?

Dr. SILBERGELD. Well Dr. Sexton was mentioning that there was a consultation through—to the Health Effects Institute from the agency, to ask them to compile information which might be existing on the subject of manganese, it was not a request to undertake research nor, as far as I know, has the Health Effects Institute in fact issued any request for proposals in the area of manganese research. This very, in my opinion, perfunctory request went to the Health Effects Institute after an office in the Office of Mobile Sources had already approved the on-board use of organo-manganese in vehicles.

Mr. PRICE. Dr. Sexton.

Dr. SEXTON. As far as I am aware, the Health Effects Institute was asked to review the existing data base on health effects of manganese, and this was done, as far as I know, well before the agency had made any decision at all. And the Health Effects Institute undertook and completed a review of existing literature, which clearly focused our eyes on some areas where research might be undertaken. So we really did at that time—which I think this was a year, year and a half ago, a fairly complete assessment as far as we could tell, of the existing health effects of manganese.

Mr. PRICE. Dr. Silbergeld, do you have anything to add? I interrupted you, could you just continue?

Dr. SILBERGELD. As I said, I will be glad to make available to you the correspondence and materials we have on the subject, which I think will speak for themselves.

Mr. PRICE. We will hold the record open for that purpose.

Dr. SILBERGELD. Thank you, sir. The other point I wanted to make was about the issue of research funding. I think you can see, even with the information you have been provided, that the funds available for research, particularly when these are specified in terms of supporting basic research, external research by the agency, are far from adequate to meeting the tasks of either dealing with the heritage of the past, the present challenges or what is likely to come. I find it even more disturbing therefore, that the administrator of the agency is seeing fit to withdraw and withhold

from the Director of the National Institute for Environmental Health Sciences the funding which was allocated by Congress under the Superfund amendments for the support of that very kind of critical research. And I urge you to inquire as to the state of that particular decision and its impact on the kinds of research that we have all identified for you.

Mr. PRICE. That decision was made by whom?

Dr. SILBERGELD. As I understand it, by Administrator Thomas.

Mr. PRICE. Any of the panelists have any comment to make on that point? Dr. Goldstein?

Dr. GOLDSTEIN. Yes, I want to say that I was Assistant Administrator for Research and Development at EPA from 1983 to 1985 under Bill Ruckelshaus and Lee Thomas. The failure to appropriate the funds under the Superfund Act has had a very major negative impact on enlisting the academic biomedical and engineering communities and ecology communities in doing the research necessary for the Superfund program.

I myself in our institute in New Jersey worked very hard to put together across unnatural types of pathways engineering people and ecologists and health scientists to be able to respond to this need. I have recently had to tell them that it is not a matter of competing with the hopes that we will win, it is a matter of a no-win situation because there is no money whatsoever, and this is after preparing a document which is about six—eight inches high of research plans and probably represents about a person year or two of activities among top notch scientists to think through what the problems could be that could be solved under the Superfund program.

This type of approach of taking the money away when it has been, if you will, put out so that the biomedical community can take a crack at it in a NIH type of process, a process which is a long, very carefully peer reviewed process requiring lots of documentation on what you are going to do, taking the money away at this late date has been very harmful to ever getting this kind of process going again.

Mr. PRICE. Now are these funds from the self-financing portion of the Superfund?

Dr. GOLDSTEIN. I believe so, yes, sir.

Dr. RALL. Perhaps I could say a few words to put this in perspective.

Mr. PRICE. Yes, Dr. Rall.

Dr. RALL. When the Superfund was reauthorized, there was a new provision in that, the so-called Wyden amendment, which requested that NIEHS set up a university-based research—interdisciplinary research program. The universities have done very well when given adequate funding of putting together superb basic research programs that lead inevitably to practical and useful applications. There is no other way you can make new advances without having a firm foundation of basic research.

This was funded for the first—this was authorized the first year with \$3 million and funded. We set up a research program, a research plan, we had an advisory committee, we had a number of superb applicants, we used the first \$3 million. This year, in the reconciliation—and I do not know whether it was Mr. Thomas, I

doubt if it was—but somewhere out of the authorized \$10 million for this fiscal year, we ended up with 5.9, and that is an enormous disappointment for about 20 universities who have put together absolutely superb applications which we have in-house, and we clearly will not be able to fund this year.

Mr. PRICE. May I just interrupt you for a moment? This \$10 million was—

Dr. RALL. Authorized.

Mr. PRICE [continuing]. Was authorized. And you received only 5.9?

Dr. RALL. Yes. Going into the reconciliation process, we had about \$9 million, and we blinked and we came out with 5.9 and I do not know what happened.

Mr. PRICE. Well was that written into the reconciliation measure?

Dr. RALL. Yes.

Mr. PRICE. In other words, this was not a matter of administrative discretion?

Dr. RALL. No, no. So it was—I suspect it was, if I may say so, Congress that did it. This year we are authorized \$20 million and the budget is ambiguous but it is somewhere between 5.9 and \$7.5 million. And again, we have superb applications in-house. I firmly believe that the universities must be enlisted to solve these important issues. I run a good basic research program here at NIEHS but when we really want the best basic research, we will go to Duke or UNC or Stanford or MIT. And I do hope that the Superfund money can—a very minor percentage of the Superfund money can be used for this program because I think in the long run it is the best way of solving previously impossible, unsolvable and intractable problems that Superfund faces today.

Mr. PRICE. Thank you.

Dr. Silbergeld, let me return to your testimony just for a moment. You spoke rather hurriedly at the end of your statement about the coming phasing out of chlorofluorocarbons and the plans to introduce substitutes without adequate testing with no data on the health effects, as you put it. Could you elaborate a bit on that assertion, and again, I would like to pull you in, Mr. Sexton, and I would like to know what kind of work EPA has underway that might be relevant to this problem.

Dr. SILBERGELD. Thank you, sir. As I stated, I was contacted by a colleague who has been involved in what I think everyone has considered extremely successful negotiations between environmentalists and the private sector with consultations with a number of governments, including our own, on the issue of coming to a rapid resolution of the chlorofluorocarbon crisis, particularly in light of the most recent data indicating the rate of destruction and the very predominant role of these chemicals in contributing to that process.

The culmination of this negotiations is apparently imminent and a number of companies, some of them multi-national chemical companies such as ICI, duPont and others, are ready to make an almost complete substitution of chlorofluorocarbons to certain of the molecules which have been shown to be much less reactive and therefore of significantly less hazard to the ozone layer. At the

very last minute, information was introduced by one of the industrial parties indicating potential toxic effects of the substitute fluorocarbon of choice—very, very preliminary data. And the question immediately arose as to whether we were trading one problem for another one. You must know of course that many of the uses of these compounds, particularly if they get reintroduced in aerosols in this country, they are still used in aerosols in other countries, will lead to very direct and potentially intensive consumer and worker exposure, in addition to the long-term global atmospheric effects.

So that the problems of assessing the immediate toxicity of these compounds are very real. It is quite clear that there is no available data base for making such inferences and EPA's much vaunted reliance on structure activity relationships, which in my opinion amounts to close to scientific fraud, will not save us in making this consideration with the speed with which it has to be made.

I think, based on what I was informed last night, that this substitution will take place, that the driving force for doing something about CFC's, doing it rapidly, is going to make this happen. But we are going to do it without the information that we need down here on earth to protect our immediate health.

Dr. RALL. Would that not come under TSCA, it would not have to go through the toxic substance process?

Dr. SILBERGELD. Unfortunately not because it is an existing chemical on the TSCA inventory and EPA's backlog of work on the existing chemicals and the laborious process of going through the interagency testing committee, a process which has failed to regulate asbestos, dioxin, formaldehyde, lead—I doubt would catch this rather exotic chemical.

Mr. PRICE. Mr. Sexton, can you help us understand what work you have underway in this area and Dr. Rall too, if that is applicable.

Dr. SEXTON. Well first of all, this is the first I heard that there was a substitution that was imminent, so I am not aware of that. At the same time, I think that we have to be very direct in saying that there is no ongoing research in EPA right now on this substitute compound. I would agree with Dr. Silbergeld, this is an area that there is almost no data on and it is important to have some. I think I would disagree strongly in terms of reliance on SAR, we never rely completely on structure activity relationships looking at a particular chemical to see if its structure would suggest its biological activity. That is a screening process that we would use as maybe a first step in helping to guide our research, and I think it is an important part of what we do. So right now, we have no ongoing research in this area.

Mr. PRICE. Dr. Rall.

Dr. RALL. This is the first I heard about the use of substitutes, so we have nothing that I know of for the CFC's.

Mr. PRICE. Dr. Goyer, if I could turn to you for just a moment. You gave I thought a very striking statement. You did concentrate mainly on Canadian studies on the presence and effects of acid rain. I wonder if—to be parochial for a moment—if you could inform us of any studies you know of that do cover the southeastern United States.

Dr. GOYER. Well actually the only Canadian study I referred to was the one that related to cadmium, but no, I am not aware of any in the southeastern United States. However, New York State has put a lot of effort into relating pH of lakes with metal content and there has been some relationship to lead content in drinking water. Those have been reported in a New York State public health document on acid precipitation, and I think that is available, and there is that relationship. I am not aware of the same effort in other parts of the country.

Mr. PRICE. I have one final question which I would like to address to Drs. Goldstein and Rall. Again it picks up on a suggested comment in your testimony about the ethical problems that you associate with the advances that we are making in measuring individual susceptibility to environmental hazards. Could you elaborate as to what the shape of those problems are?

Dr. RALL. Well very simply, we already understand the genetic background of some—that make some people very susceptible to certain compounds and certain conditions. We will increasingly be able to determine these genetic backgrounds and be able to predict that a person will be highly susceptible to one chemical or the other. What do you do then? Do you deny them employment if that is their job and they are exposed to that chemical? To what extent do you fully inform them of this? Obviously you have to tell them. There is a whole cascade of problems like this which we have to solve because the technology will move on. That is very simply—Bernie, can you—

Dr. GOLDSTEIN. I agree completely.

Mr. PRICE. What is the proper forum for dealing with these issues? Where can we begin to get to work on that?

Dr. RALL. The Academy—the Institute of Medicine, Academy of Science has had some, I guess workshops, they are not formal symposia on these issues and I would presume they would continue. That is not a bad forum.

Dr. GOLDSTEIN. I think that would be an excellent forum. I guess the fear is that the forum will be, as it so often is, the very first case that one side or the other can get through the court system. That will be chosen very carefully for impact on making that side's point of view rather than on trying to deal with what is a very difficult and sensitive issue.

Mr. PRICE. Dr. Silbergeld.

Dr. SILBERGELD. We should not overlook the fact that actually we have already made this decision, we are already taking actions which bear out a certain line of decision which many people find very distressing from the ethical and economic point of view, and that is in considering one of the basic genetic differences and that is of sex. We already permit a great number of regressive and repressive employment policies to take place merely on the often incompletely substantiated assumption that women may be more sensitive to certain toxins than are men, and I think it would behoove Congress to examine very clearly the conflicts between those kinds of implementations of so-called fetal protection policies and the right and opportunities for employment for women.

Mr. PRICE. What would be an example of this kind of abuse? Could you be a little more specific?

Dr. SILBERGELD. Certainly. I think the classic example of course was what occurred in West Virginia where the American Cyanamid Company encouraged women to obtain sterilization operations in order to hold their job positions in a higher paying position in the pigment formulations where they would come into contact with lead, cadmium and mercury.

Very similarly, unfortunately the court has just ruled that General Motors is allowed to discriminate in the hiring and promotion of women in battery operations where there may also be exposure to lead.

Mr. PRICE. But surely the problem that Dr. Rall and Dr. Goldstein are referring to is somewhat—as striking as these episodes might be—the problem they are talking about is somewhat broader, would you not agree, in terms of the dilemmas that will increasingly be proposed by research advances?

Dr. SILBERGELD. I am not sure. I think there is nothing broader than the sex difference in terms of genetic determination, and with the increasing entry of women into the workplace, I would suggest there is nothing broader in terms of the implication of this type of decision to implement genetic determinants of susceptibility. We may see this become more fragmented as we get more sophisticated understanding of gene-environment interactions. What I want to urge you is that we are already making these kinds of decisions and we have not perhaps stopped to think about them.

Mr. PRICE. But Dr. Rall, what you are talking about is differences among individuals that go considerably beyond gender differences, is that true?

Dr. RALL. Yes, but I think basically it is the same issue. One thing that disturbs me very much, Ellie, is that in many instances they have not proved that women are more susceptible to these than men. And then it is almost pro sexism I think. But susceptible groups, whether they be men versus women, whether they be this gene type as opposed to that gene type, will pose significant social problems in the future.

Mr. PRICE. Yes.

Dr. Goldstein.

Dr. GOLDSTEIN. I think it is the extent of the population that is involved as well, and certainly the breadth of the women involved in this is very important. We now accept the fact that there is a legitimate argument concerning whether a hemophiliac could be employed in a situation where there is going to be trauma. That is a reasonable argument that someone is liable to bleed and they are likely to get hurt in a situation, well perhaps they should not work in that situation. But even there there is a sense of an argument among those who feel that the work force—the job ought to be protected in such a way that there is no hope of trauma for anyone, let alone someone who is hemophiliac.

We are talking about simply putting everybody into that category because for all of us, we will be able to find that we are more or less susceptible than the average to a variety of different chemicals and then the question will be do we remove ourselves from those potential problems or do we clean up our environment and our workplace to protect ourselves.

Mr. PRICE. Even prior to that, what is the individual's right to know about his or her own susceptibility.

Yes, Mr. Fishbein.

Mr. FISHBEIN. I think the public is going to have to look increasingly to the courts for guidelines on questions related to the ethical considerations which have been discussed here. And science will be able to testify at that time, but I think the only logic in our country for determining many of these things will have to come from the courts, whether or not we like the decisions.

Mr. PRICE. Well I for one would like to see other forums employed. I would hope with Dr. Rall that we can have these discussions and that they go beyond judicial determinations.

Mr. FISHBEIN. Well I think that they will not be totally effective until the courts actually put their stamp on this.

Mr. PRICE. Well that is a different point—that is a different point than the question of who can usefully engage in these discussions.

I am sorry, Mr. Chairman, I took more time than I intended.

Mr. VALENTINE. Do not apologize, it was very helpful and instructive, your questions and answers.

I think we are getting close to the end, but I have just one more question that I would like to direct to Dr. Rall.

What role does NIEHS play in the environmental regulation?

Dr. RALL. I think it is important today to point out just what we do because we have no statutory regulatory role. We are purely a research organization, but that means also that we provide information and in preparing for a summary of the institute a few weeks ago, I reviewed the sorts of things we had done that bear directly on regulation over the last 10 or 15 years. And let me just spend a moment or two going over these.

The lead story, we have been a major participant and funder for its entire history and we feel that we have done a very good job and the new studies and the new information will protect literally thousands of unborn children.

The six city survey, you may or may not have heard of. It is an epidemiological study that began in the mid seventies to look to the effects of the so-called criteria air pollutants on the pulmonary growth and development of kids and the pulmonary function of adults. It is a beautiful study run by the Harvard Medical School and Harvard School of Public Health. It lays out the levels of SO_x / NO_x particulates and so forth, which pose essentially no hazard to people. The next Clean Air Act will be based on the six city survey.

We have done enormous amount of animal research which has led to an understanding of dioxin, PCB and polybrominated biphenyls in Michigan. We are doing an epidemiological study on PCB in mothers' milk and its effect on the children, an absolute major issue which we think we can help with enormously. More recently, ethylene dibromide, methylene chloride, paradichlorobenzene, which is carcinogenic but it happens to be your favorite moth crystal at the same time. Our research on benzene showed its pluri-potential carcinogenicity, a variety of other chemicals all of which are in the forefront of environmental problems. Since the early seventies we have supported research at Mount Sinai on asbestos and literally with our funding the whole story of the results of exposure to asbestos, the susceptibility, the major epidemic it is causing, was

laid out. We have—I will not spend much more time—we have set up major programs of developing and validating test methods. We all look for rapid tests to prioritize chemicals, but you have got to validate, you have got to find out first are they reproducible and second, do they measure what you hope they are measuring.

I might point out in addition to the fact that we find a lot of chemicals carcinogenic, we find a lot that are not carcinogenic. Ampicillin, ascorbic acid and antihistaminic chlorpheniramine, ephedrine, phenylephrine which is good for stuffed up noses, tetracycline, malathion. And most recently we have been looking at these little bits of DNA that tell cells to become carcinogenic, so-called oncogenes and proto-oncogenes, discovered by the people in the cancer field. We now are using them to identify the relationship between cancers induced in laboratory animals and in people. A significant number of women with breast cancer have a specific oncogene in their cancer that was first detected in an animal treated with a chemical carcinogen.

The basic research feeds information which is necessary for regulation and in many ways drives the regulatory process. We have an enterprise that has mostly basic research, but as that produces new information, it is that information that lets you do a better job of regulating.

Thank you.

Mr. VALENTINE. Thank you, sir.

Does anybody else have anything else you would like to add?

[No response.]

Mr. VALENTINE. If not, then let me say again to each one of you that we appreciate you sharing this time with us and we thank you for your contribution to understanding this problem. I hope and I am sure that my colleague David Price joins me in this, we are not just here to listen and to go off and move on to something else, we want to see to it that we make use of the expert testimony which has been presented here. Thank you again very much for participating.

The subcommittee is adjourned.

[Whereupon, the subcommittee was adjourned at 3:59 p.m.]

APPENDIX

ADDITIONAL MATERIAL FOR THE RECORD

ENVIRONMENTAL DEFENSE FUND

1616 P Street, NW
Washington, DC 20036
(202) 387-3500

January 15, 1987

Hon Lee Thomas
Administrator
US EPA
Washington DC 20415

We are writing to bring to your attention a sequence of decisions taken in the Air Office which potentially have very serious impacts upon human health and the environment. Even more than their content, the process whereby these decisions were made, which evaded any effective or in-depth internal or external oversight, should be deeply disturbing to all of us.

Very briefly, EPA has approved the use of organomanganese compounds as fuel additives in diesel vehicles (at present limited to those manufactured by Volkswagen, but in principle an approval available to other manufacturers of diesel vehicles as well). This approval was granted by Robert Maxwell, Director of the Certification Division of the Office of Mobile Sources, in Ann Arbor, in August of 1985 (copy of letter included). This decision evaded any public review, and possibly extensive comment in the Agency because Volkswagen proposed this new use of organomanganese NOT as a fuel additive (which would have required approval under Section 211 of the Clean Air Act) but as part of an emissions control device for diesel particulate trap regeneration.

No careful or comprehensive assessment of the health or environmental impacts of organomanganese, or combustion products of organomanganese, was undertaken. No public notice of this decision was ever given; it has come to our attention through scientific colleagues attending a meeting of the Health Effects Institute (of which more later).

Manganese is a known human health hazard. Prolonged exposure to manganese dusts is known to damage lung function and to cause a neurological disorder very similar to parkinsonism, a brain disease involving pathological damage to the brain, profound deficits in motor function, and mental deterioration. While less is known of the organomanganese compounds, there is a body of literature on MMT, previously proposed as a fuel additive by EPA in the mid-70's, which substantiates its significant biological

National Headquarters
257 Park Avenue South
New York, NY 10010
(212) 505-2100

1405 Arapahoe Avenue
Boulder, CO 80302
(303) 440-4901

2606 Dwight Way
Berkeley, CA 94704
(415) 548-8906

1108 East Main Street
Richmond, VA 23219
(804) 780-1297

Printed on Recycled Paper

activity.

The careless process whereby this decision was reached disregarded not only the information available on manganese toxicity but also the lessons which all of us should have learned from the disastrous use of organolead compounds in vehicle fuel. We are only now taking effective steps, largely during your tenure as Administrator, to reduce the widespread contamination of the US environment from this highly dispersive use of a toxic metal. Lead levels in American children are directly related to the use of lead in gasoline; when EPA began to reduce allowable levels of lead in gasoline, under Section 211 of the Clean Air Act, blood lead levels in the US population quickly responded with a healthy and significant decrease. Moreover, our experience with lead indicates that those organometals which attack the brain are even more hazardous than their inorganic "cousins" (that is, tetraethyllead is more dangerous a neurotoxin than lead oxides). It is altogether probable than organomanganese compounds, like organoleads, will be brain-seeking compounds with very high ability to penetrate into the brain and damage brain cells irreversibly.

We do not need to experiment with another toxic metal additive to gasoline. It is particularly disturbing that this decision would allow on-board installation of pure organomanganese which would then be added to the fuel in the combustion process. Thus, we face the prospect of millions of vehicles carrying potentially lethal amounts of organomanganese, ready to be released in a crash and posing an everpresent danger to auto mechanics, auto salvage workers, and others.

As you can see, the ramifications of this decision are far-reaching. Although Section 202(a)(4) of the Clean Air Act prohibits the use of any emission control device that poses an unreasonable risk to public health, the use of this organomanganese additive device was approved without an adequate consideration of the health effects of organomanganese compounds, or this extraordinarily risky use of them. Very little attempt was made to involve relevant offices at EPA, such as OAQPS or OHEA, in this decision. A cursory review of the potential impacts was undertaken by the Health Effects Institute, upon the request of Volkswagen; this review (a copy attached) casts very serious doubt upon the utility of this Institute, in our opinion, to deliver reliable or comprehensive information of use to the Agency in decisionmaking. In fact, the decision to approve this request by VW only came to light at a meeting held by HEI, where brief mention was made of their review of manganese health effects.

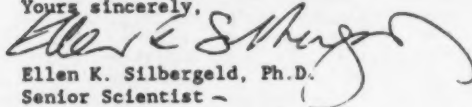
A question might arise as to whether a deliberate bypassing of appropriate EPA review was undertaken by certain parts of the Air Office. In the 1970's, EPA approved the increased

use of organomanganese (MMT) as a gasoline additive without appropriate review under the Clean Air Act; upon protest from health experts outside the EPA, this approval was withdrawn. It is doubtful that any health panel would approve such a use of manganese, with all its implications of ubiquitous contamination, problems in abatement, and probably impacts upon human health.

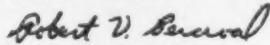
We bring this matter to your attention because of the very serious process errors involved. We believe that the approval of onboard devices containing organomanganese is an endangerment of public health. The way in which this decision sneaked through the Agency, past all outside scientific and public review, can only raise real concerns among all of us who care about the effectiveness of our protective laws and the open process by which we customarily reach decisions.

We would be pleased to meet with you and the Assistant Administrator for Air to discuss this matter further.

Yours sincerely,



Ellen K. Silbergeld, Ph.D.
Senior Scientist -



Robert V. Percival
Senior Attorney

enc



888 W. Big Beaver
P.O. Box 3951
Troy, Michigan 48069
Tel. 313/363-6000
Western Union Telex 230 628

December 14, 1983

Mr. Barry R. Wallerstein
Associate Air Pollution Specialist
Air Resources Board
Mobile Source Control Division
9528 Telstar Avenue
El Monte, California 91731

Dear Mr. Wallerstein:

On November 15, 1983, Volkswagen met with you and Mr. S. Albu, of the California Air Resources Board (CARB) Staff, to discuss the use of a manganese additive for diesel particulate trap regeneration. In particular, Volkswagen presented responses to specific CARB questions regarding the concentration and the emission and chemical characteristics of the manganese additive. The following provides, and to some extent expands upon, in writing, Volkswagen's statements at the above-mentioned meeting. For the sake of clarity, we have provided our understanding of the CARB question prior to each response. Responses are based upon testing carried out on a Quantum Turbo-diesel vehicle.

1. What specific chemical form (i.e., compound) of Manganese is VW intending to use?

The additive intended to be used by VW will be an organic manganese compound that is in solution with Xylene. The manganese is bonded to a fatty acid. The exact formula of the manganese compound is not known to us because its manufacturer, The Lubrizol Corporation, Ohio, claims the formula to be proprietary.

2. What amount of additive, in a quantifiable unit (g/gal), is being added to the fuel?

The additive is supplied to the fuel line at a location before the injection pump. This strategy, rather than

Mr. Barry Wallerstein
December 14, 1983

Page 2

addition of the additive to the fuel tank, is used so that there will never be an excess of additive in the fuel. Also, as part of the additive use strategy, Volkswagen plans to have vehicles carry a life-time supply of additive, in a container separate from the fuel tank, so that the consumer does not need to add additive to the fuel. Using this technique, the quantity injected into the fuel supply amounts to approximately 0.08 grams Mn/gal of diesel fuel or 0.0024 grams Mn/mile.

3. What major species of manganese compounds are emitted in the exhaust gas?

From early test results, VW cannot detect any manganese in the exhaust gas. Given the small concentration of 2.4 mg Mn/mi that is added to the fuel, we can expect only minute concentrations of manganese in the exhaust gas. These concentrations are, thus far, under the detection limit of our analytical methods. VW is working on improvements in sampling methods which would enable us to perform chemical characterization analysis. At this time, VW can only speculate that following combustion, the manganese will be emitted in the form of manganese oxides or sulfates.

4. How much manganese does the trap retain; or, what are the total tailpipe emissions of manganese?

As mentioned in response to question 3 above, we are attempting to improve the analytical methods in order to detect manganese in the exhaust gas. There is definitely some manganese retained on the trap. However, because of the limited durability testing conducted thus far, VW is unable to quantify the amount of manganese retained. Once we have traps that have been subjected to greater mileage accumulation using the additive system, we will be able to provide a quantitative response.

Mr. Barry Wallerstein
December 14, 1983

Page 3

5. What is the exact amount and concentration of additive stored in the container on-board?

According to current test results, approximately 7 liters of additive would be required to be stored for 100,000 miles of vehicles use. The concentration of the manganese in the Xylene amounts to 4.00%.

We hope this information is useful in your analysis of additive regeneration systems. If there are any questions regarding our response, do not hesitate to contact me.

Best regards,


Wolfgang Foth
Manager
Emissions & Fuel Economy
LWK/cs

bcc: K.-H. Neumann/Barthel
Dr. Engeler
Dr. Wiedemann
D.K. Haenchen



UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
ANN ARBOR, MICHIGAN 48105

OFFICE OF
AIR, NOISE AND RADIATION

EMISSION REGULATIONS
VOLKSWAGEN OF AMERICA
RECEIVED

JUN 22 1984

JUN 23 1984

Mr. Wolfgang Groth, Manager
Emissions & Fuel Economy
Volkswagen of America, Inc.
888 W. Big Beaver
P.O. Box 3951
Troy, Michigan 48007-3951

Dear Mr. Groth:

Thank you for your transmittal to Charles Gray of June 11 discussing the use of a manganese additive with light duty diesels equipped with particulate traps. Both Dr. Joe Somers and I reviewed your submittal; this letter contains some comments which we feel will be helpful to you.

Our calculations on the ambient levels of manganese that would result from use of this additive agree with yours. Also, to the best of our knowledge, you have summarized the available health effects data. Our only comment is that there appears to be little inhalation health data on manganese at lower levels (e.g., 0.01 mg/m^3) such as projected in your report in localized areas if all vehicles used fuel containing 0.08 g/gal manganese and all of the manganese were emitted in the exhaust. This fuel manganese level is similar to the level of MMT proposed for use in unleaded gasoline several years ago. At this point, neither Joe nor I can say for sure that additional inhalation health data are needed for manganese at low levels. However, we feel that VW should consider obtaining additional inhalation health data at low levels possibly through the Health Effects Institute.

We both feel the VW report is a good one but that additional health data on lower manganese levels would be useful.

Sincerely yours,

Phil Lorang
Phil Lorang, Chief
Technical Support Staff

**VOLKSWAGEN
OF AMERICA, INC.**

800 W. Big Beaver
P.O. Box 3961
Troy, Michigan 48007-3961
Tel. 313/362-6000
Western Union Telex 230 628

August 23, 1984

Robert Maxwell
Director, Certification Division
U.S. Environmental Protection Agency
2565 Plymouth Road
Ann Arbor, MI 48105

Subject: Clean Air Act Section 202(a)(4) Compliance for Particulate
Control Systems

Dear Mr. Maxwell:

Beginning with the 1986 model year, manufacturers of diesel-powered vehicles intended for sale in California will be subject to a 0.2 gram per mile (g/mi) particulate emission standard. Consequently, Volkswagen will be required to install diesel particulate control hardware which has never before been utilized on Volkswagen's, or any other manufacturer's, production vehicles. Similarly, the 1987 Federal diesel particulate standard of 0.2 g/mi will require installation of the same system. This hardware consists of elements of design, a fuel additive-based particulate trap regeneration system, which Volkswagen believes warranted assessment under the requirements of Section 202(a)(4) of The Clean Air Act.

Section 202(a)(4) requires assurance that the system in question does not cause or contribute to an unreasonable risk to the public health, welfare, or safety in its operation or function. Volkswagen understands that demonstration of compliance with the requirements of this Section, is the responsibility of the manufacturer according to the requirements of Section 206(a)(3)(A) of the Act. Section 206(a)(3)(A) also requires the Administrator to determine whether the manufacturer has established, to the Administrator's satisfaction, that the system in question conforms to the applicable requirements of Section 202(a)(4). Volkswagen has pursued an investigation of the health hazards which may be associated with our primary diesel particulate emission control system and submitted our findings in a June 11, 1984 letter to Mr. Charles Gray, Director, Emission Control Technology Division. Enclosed is a copy of our submittal (Enclosure I). On June 22, 1984, Mr. Phil Lorang, Chief,

Porsche Audi Volkswagen

Mr. R. Maxwell
August 23, 1984

Page 2

Technical Support Staff, responded to our correspondence (Enclosure II). With Volkswagen's June 11 letter the requirements of Section 202(a)(4) were thought to be met. Volkswagen therefore requests that the Administrator assess the information provided and determine if the requirements of Section 202(a)(4) are met, for the purposes of ultimately granting a Certificate of Conformity, to the satisfaction of the Administrator.

Volkswagen is aware that EPA has published guidance on compliance with the sections of the Act cited above. The guidance, OMSAPC Advisory Circulars (A/C) 75 and 76-1, deal specifically with the 1979 and 1980 model years. However, since no more recent A/C has been issued on this subject, Volkswagen assumes that EPA would defer to these existing policy documents. A/C 76 provides that EPA will not require submission of methodology and analytical details of the manufacturer's assessment of risk prior to granting a certificate. In this instance, Volkswagen is requesting EPA's concurrence prior to the submission of any request for emission certification because of the unique concept represented by this control strategy. Further, awaiting approval of this system until the certification review process, subjects Volkswagen to a financial risk. Considerable financial loss would be the result of cancellation of production of the fuel additive particulate control system if disapproved just prior to the beginning of the 1986 model year. Volkswagen must begin, late in the 1984 calendar year, to make the necessary production-related preparations, such as completion of design, tooling and vendor agreements, if this system is to be installed in 1986 model year vehicles at start of production. Moreover, a denial would result in a withdrawal from the diesel market in California for the 1986 model year, and perhaps nationwide in 1987 as well, since an alternative control system is not available.

Volkswagen trusts that their concerns and needs have been adequately described herein. In order to assist EPA in determining if Volkswagen has established compliance with Section 202(a)(4) at this early date, some information which briefly describes our primary diesel particulate emission control system follows.

The control system basically consists of a ceramic diesel particulate trap and regeneration system which uses a manganese-based additive. The system is shown conceptually on the enclosed schematic (see Enclosure III). The additive is used to reduce the temperature at which the collected particulate matter

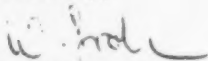
Mr. R. Maxwell
August 22, 1984

Page 3

will burn off of the trapping medium. The mechanism by which this type of regeneration takes place has been described in two Volkswagen-prepared SAE papers (Enclosures IV and V). In the most recent configuration of this system, the particulate trap is coated with the manganese additive, during the manufacturing process, to avoid the need for "seasoning" of the filter medium and allow for immediate regeneration capability. Regeneration of the trap throughout mileage accumulation is accomplished by continuous injection of the manganese-based additive into the fuel delivery system. Early assessment of the amounts and concentrations of fuel additive necessary for the regeneration to take place and the concentration of manganese emitted into the ambient air was provided in response to specific California Air Resources Board questions on this issue. A copy of our response is enclosed for your information (Enclosure VI).

Because of the time constraints Volkswagen is under, your expeditious review of the documents provided and response to whether Volkswagen has demonstrated compliance with the requirements of Section 202(a)(4) of the Act, to the Administrator's satisfaction, is requested.

Sincerely,


W. Groth
Manager
Emissions & Fuel Economy
LWK/cs

Enclosures (6)

cc: Charles Gray ✓

Phil J. Pomeroy



**VOLKSWAGEN
OF AMERICA, INC.**

880 W. Big Beaver
P.O. Box 3951
Troy, Michigan 48007-3951
Tel. 313/362-6000
Western Union Telex 250 629

September 18, 1984

Charles Gray, Director
Emission Control Technology Division
Motor Vehicle Emission Lab
U.S. Environmental Protection Agency
2565 Plymouth Rd.
Ann Arbor, Michigan 48105

Dear Mr. Gray:

Subject: Manganese Fuel Additive

Enclosed is a copy of a letter we recently received
from the Health Effects Institute concerning manganese
as a fuel additive.

We are supplying this letter for your information.

Sincerely,

W. Groth

W. Groth
Manager
Emission Regulations & Certification
/cs

Enclosure

THE HEALTH EFFECTS INSTITUTE

Board of Directors

Archibald Cox, Chairman
William O. Baker
Donald Kennedy

Executive Director
Charles W. Powers

215 First Street
Cambridge, Massachusetts 02142

(617) 491-2926

EMISSION REGULATIONS
VOLKSWAGEN OF AMERICA
RECEIVED

SEP 1 1984

ATTN:

September 14, 1984

cc: [unclear]
[unclear]
[unclear]

Mr. Wolfgang Groth
Manager
Emissions and Fuel Economy
Volkswagen of America, Inc.
888 West Big Beaver Road
P.O. Box 3951
Troy, MI 48007

Dear Mr. Groth:

It was good to meet you last month in Detroit. This letter follows up on both our conversation at MVMA and more particularly your letter to HEI of June 29, 1984, concerning the potential use of manganese as a fuel additive for particulate trap regeneration.

The Health Research Committee of the Institute took up the Volkswagen-Fraunhofer evaluation of manganese at its September 6, 1984, meeting. The Committee was quite enthusiastic about HEI's potential to assist manufacturers in fulfilling their responsibilities with respect to Section 202 (a)(4) of the Clean Air Act. We think it is possible, through improved scientific communication among HEI, the Government and manufacturers, to provide a way to deal with "unregulated" substances and technologies that will enhance public understanding of and promote confidence in emerging technologies.

Because of this recognition of the importance and value of its task, the Research Committee wants to be certain that it provides a scientific opinion concerning the current state of knowledge about manganese and potential additional research that will be useful to Volkswagen and to the other manufacturers that have expressed interest in this matter.

In this regard, the Committee believes that a number of questions remain open before a definitive evaluation can be completed. These questions primarily involve the identification and quantification of manganese additive combustion products, potential human exposure to them, and the adequacy of currently available toxicologic and epidemiological literature on manganese.

The first set of unknowns concerns the additive Lubrizol 8220. The report prepared by the Fraunhofer Institute indicates that "No information is available with regard to Lubrizol applications in connection with diesel trap oxidizers and their regeneration" (1), and further that "There are no studies available on the toxicity of Lubrizol 8220 or its combustion products." (2) Our preliminary investigations have revealed nothing to contradict these statements; we do not know yet whether some of the gaps can be filled with unpublished information.

Despite the limited chemical information, the authors of the VW report's first section estimated worst-case ambient concentrations of manganese, and further suggested that the metal probably is in inorganic form once emitted. This approach is of considerable value since it offers a manner in which future questions of exposure may be addressed regardless of the metal compound's chemical form.

The lack of information on Lubrizol 8220 and its combustion products was felt most sharply in connection with the health assessment. The Fraunhofer reviewers, in an attempt to anticipate possible health issues related to Lubrizol emissions, examined the literature related to combustion products of MMT. Upon combustion, manganese in MMT is apparently converted mainly to inorganic oxide. Even though the literature cited is negative, we cannot yet convincingly argue that Lubrizol 8220 is similarly combusted.

Further, chronic inhalation of manganese has not been extensively studied in animals, nor has an animal model of manganese inoxidation been developed. In addition, the epidemiological studies to date are probably not sensitive enough to detect potential subtle effects, do not yield dose-response data, and fail to consider the possible existence of sensitive populations.

(1) Fraunhofer-Institut fuer Toxikologie und Aerosolforschung Institutsteil Hannover/Muenster. Evaluation of Health Effects Associated with the use of a Manganese Additive in Connection with the Diesel Trap Oxidizer Regeneration. Under Contract to Volkswagenwerk AG. Feb. 1984, page 1

(2) *ibid.* page 25

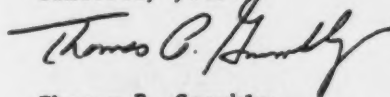
The scientific health issues related to airborne manganese exposures were reviewed by the WHO in 1981. Their conclusions were cautiously phrased and suggested that effects from exposure levels similar to, or lower than, those in the worst-case VW scenarios could not be ruled out. Since 1981, little research on manganese has taken place. In light of the documentation usually required to understand adequately questions with implications to the public health, we believe that currently available published information on manganese is insufficient. On the other hand, we have seen no evidence linking low-level inorganic manganese airborne exposure to overt toxicity.

During the remainder of 1984, and into early 1985, the Research Committee will be developing, with the aid of HEI technical staff and appropriate experts, a comprehensive analysis of the manganese issue that will attempt to ensure that both published and unpublished data are evaluated. On the basis of this work, the Committee will recommend an appropriate program of research if one is required. It will also ask that the Board of Directors convey to you its evaluation of the existing evidence so that you may utilize the judgments of HEI in fulfilling your responsibilities under the law. This evaluation will not reach ultimate policy judgments about whether manganese under the proposed conditions of use is safe. It will, however, attempt to answer, from a scientific perspective, whether significant questions about manganese remain, or whether a substantively accurate assessment can already be made. It is in pursuit of the scientific objective that access by HEI staff to work in progress or unpublished data available would be particularly helpful. I will be soliciting your assistance in the near future in this regard.

In sum, HEI is not yet prepared to provide the final answers you seek. We do not see important problems at this time, but we do not want to give you a superficial evaluation that may not be useful. Therefore, we are committing significant resources to develop an evaluation that will be credible to EPA, to the public and available in the near future.

I know I speak for the Research Committee and the Board of Directors in thanking Volkswagen for its request. We look forward to working with you and other concerned sponsors in the months ahead.

Sincerely yours,



Thomas P. Grumbly
Deputy Executive Director

TPG/ELM

THE LUBRIZOL CORPORATION

29400 LAKELAND BOULEVARD WICKLIFFE, OHIO 44092
216/943-4200

October 18, 1984

Mr. Joe Somers
U.S. Environmental Protection Agency
2565 Plymouth Road
Ann Arbor, Michigan - 48105

Dear Mr. Somers:

In response to a request from Mr. Robert C. Tupa, we are pleased to send you the enclosed Material Safety Data Sheet for the following Lubrizol product:

Lubrizol 8220

If we can be of any further assistance in this matter, please let us know.

Very truly yours,

THE LUBRIZOL CORPORATION

Grace E. Shupp

Grace E. Shupp
Health and Safety Information
Specialist

ges/#5567G
Enclosure

"THE INFORMATION PRESENTED HEREIN HAS BEEN COMPILED FROM SOURCES CONSIDERED TO BE DEPENDABLE AND IS ACCURATE TO THE BEST OF SELLER'S KNOWLEDGE. HOWEVER, SELLER MAKES NO WARRANTY WHATSOEVER, EXPRESSED, IMPLIED OR OF MERCHANTABILITY REGARDING THE ACCURACY OF SUCH DATA OR THE RESULTS TO BE OBTAINED FROM THE USE THEREOF. SELLER ASSUMES NO RESPONSIBILITY FOR INJURY TO BUYER OR TO THIRD PERSONS OR FOR ANY DAMAGE TO ANY PROPERTY AND BUYER ASSUMES ALL SUCH RISKS."

MATERIAL SAFETY DATA SHEET

NPVLA 6-70

(Approved by U. S. Department of Labor "Essentially Similar" to form LSH-005-4)

Section I					
MANUFACTURER'S NAME					
THE LUBRIZOL CORPORATION					
STREET ADDRESS					
29400 Lakeland Blvd.					
CITY, STATE AND ZIP CODE					
Wickliffe, Ohio - 44092					
EMERGENCY TELEPHONE NO.					
216/943-4200					
CHEMICAL NAME AND SYNONYMS				TRADE NAME	
				LUBRIZOL 8220	
CHEMICAL FAMILY				FORMULA	
PAINTS, PRESERVATIVES, & SOLVENTS					
PIGMENTS	%	TLV (Units)	SOLVENTS	%	TLV (Units)
CATALYST			ADDITIVES		
INCLE			OTHERS		
HAZARDOUS MIXTURES OF OTHER LIQUIDS, SOLIDS, OR GASES				%	TLV (Units)
COMBUSTIBLE!					
Product contains Xylene. (Xylene contains <0.1% benzene)					
Product contains aromatic hydrocarbon solvent					
Product contains manganese compound					5mg/m ³
BOILING POINT (°F.)					
Not Determined		SPECIFIC GRAVITY (H ₂ O=1)		0.935	
		@ 15.6°C			
VAPOR PRESSURE (mm Hg.)		PERCENT VOLATILE BY VOLUME (%)		Not Determined	
Not Determined					
VAPOR DENSITY (AIR=1)		EVAPORATION RATE (.....=1)		Not Determined	
Not Determined					
SOLUBILITY IN WATER					
Insoluble					
APPEARANCE AND ODOR					
Dark Colored Liquid					
Mild Odor					
FLASH POINT (METHOD USED)		FLAMMABLE LIMITS		Let	
40°C (FMCC)		Not Determined		Use	
EXTINGUISHING MEDIA		CO ₂ , dry chemical, foam			
SPECIAL FIRE FIGHTING PROCEDURES		See above			
UNUSUAL FIRE AND EXPLOSION HAZARDS					
COMBUSTIBLE! Avoid excessive heat, sparks or open flames.					

1/19/84

LUBRIZOL 6220

Section V - HEALTH HAZARD DATA

THRESHOLD LIMIT VALUE

No OSHA exposure standard or threshold limit value has been established for this product.

EFFECTS OF OVEREXPOSURE

CAUTION: Possible eye irritant. Avoid contact. Product is not expected to be a primary skin irritant but minor irritation may occur after prolonged or repeated contact. Avoid such exposure. Inhalation may cause respiratory irritation, dizziness, nausea and headache.

EMERGENCY AND FIRST AID PROCEDURES

For eye contact: Flush immediately with plenty of water for at least 15 minutes. For skin contact: Wash with soap and water. Inhalation: Remove to fresh air. Apply artificial respiration if breathing has stopped and call a physician.

Section VI - REACTIVITY DATA

STABILITY	UNSTABLE	CONDITIONS TO AVOID
	STABLE	
		Avoid temperatures above 37.8°C.
		X
INCOMPATIBILITY (Materials to avoid)		
Strong oxidizing agents		
HAZARDOUS DECOMPOSITION PRODUCTS		
Thermal decomposition or burning may produce oxides of carbon, nitrogen and manganese		
HAZARDOUS POLYMERIZATION	MAY OCCUR	CONDITIONS TO AVOID
	WILL NOT OCCUR	
		X

Section VII - SPILL OR LEAK PROCEDURES

STEPS TO BE TAKEN IN CASE MATERIAL IS RELEASED OR SPILLED

Handle as an oil spill. Avoid breathing vapors or mists - use adequate ventilation.
Prevent entry into sewers and waterways.

WASTE DISPOSAL METHOD

Chemical waste disposal is governed by the Resource Conservation and Recovery Act as well as other local, state and federal laws and regulations.

Section VIII - SPECIAL PROTECTION INFORMATION

RESPIRATORY PROTECTION (Specify type)

VENTILATION	LOCAL EXHAUST	SPECIAL
	MECHANICAL (General)	
		OTHER
	X	
PROTECTIVE GLOVES		EYE PROTECTION
Plastic or rubber gloves recommended		Chemical Splash Goggles Recommended
OTHER PROTECTIVE EQUIPMENT		
Above protective devices are recommended to conform with recognized hygienic practices when handling chemicals.		

PRECAUTIONS TO BE TAKEN IN HANDLING AND STORING

CAUTION! COMBUSTIBLE! Store at temperatures below 37.8°C. Store in a cool, dry area in tightly closed containers. Use adequate ventilation - avoid breathing vapors or mists.

OTHER PRECAUTIONS

Avoid excessive heat, sparks or open flames. Normal hygienic and safety precautions should be observed when handling chemicals. Avoid contact with the eyes and skin. Wash thoroughly after handling.

NOV 6 1984

Mr. Robert C. Tupa
The Lubrizol Corporation
29400 Lakeland boulevard
Wickliffe, Ohio 44092

Dear Mr. Tupa:

Thank you for the material safety data sheet you sent me October 18 in response to my request of August 31. As you know, we would like any information available on the health effects of the manganese containing compound (Lubrizol 8220) that VW is considering using for trap regeneration for future light duty diesels.

In particular, we are interested in any animal or other toxicity data that is used to determine the effects of overexposure as described on the second page of your write-up as well as the TLV. We are particularly interested in any information exposure levels at which these effects occur.

One potential concern we need to evaluate is health effects due to exposure from spillage of the additive itself from the container in the vehicle. Thus, health data from exposure to higher levels of this compound (as well as lower levels) would be useful.

Please call me (313-668-4321) if you have any questions on this request.

Sincerely yours,

Joseph H. Somers
Project Manager
Technical Support Staff

TSS:Somers:slj:X428:2565PLYMOUTH RD.:3096G:11/05/84

STATE OF CALIFORNIA

AIR RESOURCES BOARD

1100 O STREET
P.O. BOX 2813
SACRAMENTO, CA 95812

Rec'd 8 Apr 1985

January 16, 1985

TO: ALL PASSENGER CAR MANUFACTURERS
ALL LIGHT-DUTY TRUCK MANUFACTURERS
ALL MEDIUM-DUTY VEHICLE MANUFACTURERS
ALL HEAVY-DUTY ENGINE AND VEHICLE MANUFACTURERS
OTHER INTERESTED PARTIES

At the November 29, 1984 meeting of the Air Resources Board, I discussed with Board members the public health and policy implications attendant to the use of manganese or manganese compounds in diesel particulate traps. The purpose of this letter is to convey to you the essential points of that discussion.

Preliminary analysis by ARB staff has revealed evidence that, in certain concentrations, manganese causes neurologic and respiratory disorders. In addition, there is evidence based on animal studies that manganese is mutagenic and possibly carcinogenic.

The Board's staff has studied the potential for use of manganese in diesel particulate traps, and finds that only a small number of vehicles is expected to use this additive over the next few years as a means of complying with the particulate standard for light duty vehicles for 1986 and subsequent model years. Based on air quality modeling, the staff has determined that in the immediate future, the ambient concentrations of manganese that would result from the minimal use expected are not high enough to pose an additional public health risk. Thus, at this time we will take no action to restrict the use of manganese in trap-equipped diesel vehicles. The Board is, however, very concerned that more extensive use of manganese in these vehicles may pose a threat to public health.

Because of its potential for toxicity, there are several factors which suggest that continued use of manganese as an element of particulate emission control system design may not be a prudent course of action. First, if more new vehicles are designed to utilize manganese additives, the ambient concentrations of manganese will increase and may reach a level at which a public health risk is anticipated. This, of course, would be of less concern if manufacturers develop means of assuring the trap retains all or nearly all of the fuel additive. Second, further study of the effects of exposure to manganese may disclose additional health risks. I will be asking the Health Effects Institute to assist us in assessing the health effects of manganese. Should either of these developments occur, the Board will have to reconsider its position.

-2-

We must also consider these factors with respect to the use of other potentially toxic compounds in diesel emission control technology. While we are dedicated to reducing particulate emissions from diesel powered vehicles, we must be very cautious about the use of toxic compounds.

I commend those manufacturers who have developed the particulate control technology necessary to help California meet its air quality needs. I hope the same level of enthusiasm and effort will now be applied to developing alternative techniques which do not depend on use of toxic materials which may be emitted into the atmosphere.

Sincerely,



Gordon D. Bell
Chairman

Mail Out # 85-49

STATE OF CALIFORNIA

AIR RESOURCES BOARD

1102 G STREET
P.O. BOX 2815
SACRAMENTO, CA 95812
(916) 445-4383

George Durumham
GEORGE DURUMHAM, Governor

Penny JR
MAR 6 1985



February 20, 1985

Mr. Charles W. Powers, Executive Director
The Health Effects Institute
215 First Street
Cambridge, MA 02142

Dear Mr. Powers:

As you may be aware, the California Air Resources Board (the "Board") will require automobile manufacturers to reduce diesel particulate emissions from 1986 model year vehicles. The initial 0.2 gram per mile standard will require many manufacturers to employ trap oxidizer technology, and by 1989 the 0.08 gram per mile standard will force this technology on all light-duty diesels sold in California. In order to meet these standards, some manufacturers are considering a technology that would require the use of a manganese fuel additive which acts as a catalyst for trap regeneration. The Board is concerned about the possible health risk that may be associated with the widespread use of this substance by the automobile industry.

It is my understanding that in June of 1984, Volkswagen of America requested that your Institute determine whether or not further health assessment was warranted, especially regarding exposure to low ambient levels of manganese. In a subsequent response (Thomas P. Grumbly, HEI, to Wolfgang Groth, Volkswagen of America, dated Sept. 14, 1984), your Institute indicated that it will be committing significant resources in evaluating the available data on manganese health effects and, on the basis of that work, recommend an appropriate program of research if one is required.

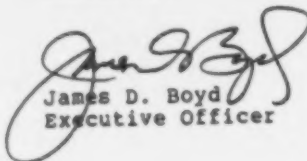
In light of the Board's concern regarding the possible use and potential risk of manganese in California, I would like to communicate our support of your efforts in evaluating the data available regarding the health effects of manganese.

Mr. Charles W. Powers

2.

If I or my staff can be of any assistance, please let me know. I may be contacted at (916) 445-4383. I would also appreciate your keeping me informed of future developments concerning this matter.

Sincerely,



James D. Boyd
Executive Officer

bcc -
R. Wilson
RZ
KDD
WWS

CALIFORNIA RESOURCES AGENCY

AIR RESOURCES BOARD
HAAGEN-SMIT LABORATORY
9528 TELSTAR AVENUE
EL MONTE 91731
PHONE (213) 575-0800

MAIL OUT # 85-07

GEORGE DEVAJIAN, Governor



APR 02 1985

March 29, 1985

TO: ALL PASSENGER CAR, LIGHT-DUTY TRUCK, MEDIUM-DUTY VEHICLE, HEAVY-DUTY ENGINE MANUFACTURERS; AND OTHER INTERESTED PARTIES

This Mail Out conveys two items of general interest to manufacturers of light-duty diesel engines. The first is the attached letter from Chairman Duffy to Mr. Karl-Heinz Ziwick of BMW. It denies a petition from BMW for reconsideration of California's 0.2 g/mi particulate emission standard applicable to light and medium-duty 1986 diesel vehicles. In the letter Mr. Duffy stresses the Board's resolve to obtain compliance with the standard.

The second item is related to the use of fuel additives to facilitate diesel particulate trap regeneration. Attachment II is Mail Out #85-49 which responded to issues raised by Volkswagen and which I understand may have been misinterpreted by some manufacturers as an endorsement of diesel fuel additives by the California Air Resources Board (CARB).

I wish to stress that at the September 1984 Board Hearing discussion of this issue, the Board and CARB staff expressed their concern about possible adverse health impacts from the use of diesel fuel additives as a means of particulate control. CARB has taken no action at this time to prohibit use of manganese as a diesel fuel additive because projected use over the next few years will not result in ambient concentrations of manganese reaching a level which could cause adverse health effects. Should manufacturers continue to use manganese beyond the next few years, and assuming the assumptions in our analysis do not prove overly conservative, ambient levels may increase and the Board will have to consider taking action to restrict use of manganese in diesel fuel. Thus Mr. Duffy in his Mail Out indicates that continued use of manganese as a diesel fuel additive may not be a prudent course of action for manufacturers to follow. CARB will evaluate the effect of other diesel fuel additives under consideration in a similar manner.

If you have any questions regarding these subjects, please call Bob Cross of our staff at (818)575-6918.

Sincerely,

K. D. Drachand
K. D. Drachand, Chief
Mobile Source Division

Attachments

manufacturers have either voluntarily canceled their registration for this use or have had sale and distribution of their CCL products suspended by the Agency for failure to comply with this requirement. Production of fumigants containing CCL was discontinued as of December 1984, and sales (distribution and use) of existing stocks are to be discontinued as of the end of 1985.

Under Executive Order 12291, EPA must judge whether this action is "major" and therefore subject to the requirement of a Regulatory Impact Analysis. This action is not major because it imposes no additional regulatory requirements on States or sources. This proposal was submitted to the Office of Management and Budget (OMB) for review. Any written comments from OMB and any written EPA responses are available in the docket. Pursuant to 5 U.S.C. 605(g), I hereby certify that this action will not have a significant economic impact on a substantial number of small entities because it imposes no new requirements. This action does not contain any information collection requirements subject to OMB review under the Paperwork Reduction Act of 1980.

Dated: August 2, 1985.

Lee M. Thomas,

Administrator.

References

- EPA [U.S. Environmental Protection Agency] (1984). Health Assessment Document for Carbon Tetrachloride. Environmental Criteria and Assessment Office, Office of Research and Development, Cincinnati, Ohio. EPA-600/9-82-001F.
- EPA [U.S. Environmental Protection Agency] (1985). "Survey of Carbon Tetrachloride Emission Sources." Final Report. Office of Air Quality Planning and Standards, Research Triangle Park, N.C. EPA-450/3-85-018.
- Hunt, W.F. (1984). Memorandum, "Revised National Cancer Incidence Rate for Carbon Tetrachloride." U.S. Environmental Protection Agency, Office of Air Quality Planning and Standards, Research Triangle Park, N.C. (July 17, 1985).
- Simmonds, P.G., F.N. Alyea, C.A. Cardelino, A.J. Crawford, D.M. Cunnold, B.C. Lane, J.E. Lovelock, R.G. Prinn, and R.A. Rasmussen (1983). The Atmospheric Lifetime Experiment: 6. Results for carbon tetrachloride based on 3 years data. J. Geophys. Res. 88(C13): 8427-8441.
- Zaragoza, L.J. (1985). Exposure and Risk Analysis for Carbon Tetrachloride. Memorandum to the Files.
- [FR Doc. 85-19197 Filed 8-12-85; 8:45 am]
- BILLING CODE 1605-00-01

[AD-FRL 2672-3]

Decision Not To Regulate Manganese Under the Clean Air Act

AGENCY: Environmental Protection Agency.

ACTION: Notice Regarding Manganese.

SUMMARY: The Environmental Protection Agency has determined that present ambient air concentrations of manganese do not pose a significant risk to public health and that no regulation directed specifically at manganese is necessary at this time under the Clean Air Act. This determination has no effect on the regulation of particulate matter, which can include manganese, for which a national ambient air quality standard (NAAQS) to protect public health and welfare has been established. This decision does not preclude State and/or local air pollution control agencies from specifically regulating emission sources of manganese.

ADDRESSES: All information relevant to this decision is in Docket No. A-84-9 located in the Central Docket Section of the U.S. Environmental Protection Agency, West Tower Lobby Gallery I, 401 M Street, SW., Washington, D.C. The docket may be inspected between 8:00 a.m. and 4:30 p.m. on weekdays, and a reasonable fee may be charged for copying.

Availability of related information: The final Health Assessment Document (HAD) for Manganese (EPA 600/8-83-013F) is available through the U.S. Department of Commerce, National Technical Information Service, 5285 Port Royal Road, Springfield, Virginia 22161, telephone number 703-487-4650. Request Document Number PB 84-229954 (cost \$28.00).

FOR FURTHER INFORMATION CONTACT: Mr. Robert Schell, Strategies and Air Standards Division, MD-12, U.S. Environmental Protection Agency, Research Triangle Park, North Carolina, 27711 (919-541-5645).

SUPPLEMENTARY INFORMATION: Manganese is a common element existing in the earth's crust mainly in the form of oxides and carbonates. Manganese is emitted as a component of particulate matter during processes that utilize ores and during combustion of fossil fuels. Manganese (CAS Number 7439-06-5) was originally placed under assessment because of a potential for significant public exposure and concern that it might be carcinogenic in humans.

EPA's assessment is contained in a report entitled "Health Assessment Document for Manganese" (EPA 600/8-83-013F). A draft of this report was

made available for public review. It was reviewed at a public meeting held by EPA's Science Advisory Board (SAB) on November 10, 1983. The SAB is an independent non-government scientists formed to advise the Administrator on scientific matters. The findings of the report were (1) that public exposure to manganese is presently far below any level associated with non-carcinogenic serious health effects, and (2) that evidence currently available does not indicate that manganese is carcinogenic. The SAB requested minor changes to the document but agreed with these major findings. Transcripts of the SAB review are available for inspection and copying at the U.S. Environmental Protection Agency, Vicki Bailey, Committee Management Staff, A-101, Room 2515, 401 M Street, SW., Washington, D.C. 20460, telephone (202) 382-5036. The final document incorporates the changes requested by the SAB and is available through the U.S. Department of Commerce, National Technical Information Service.

The HAD for Manganese reports that the toxicity of numerous manganese compounds has been tested in animals by all common routes of exposure. Chronic occupational exposure to particulate matter containing concentrations of manganese of 5 milligrams per cubic meter (mg/m³) or greater has resulted in a severe central nervous system disorder in humans known as manganism. This is a result of manganese being absorbed into the blood stream over an extended period of time and accumulating in the brain. Manganese fumes as well as fumes of many other heavy metals have been known to cause an acute illness called metal fume fever in workers immediately exposed in confined occupational settings to high concentrations of metallic fumes such as those associated with welding operations. Particulate matter which may or may not contain manganese has been associated with increased incidence of common respiratory ailments in both occupationally exposed people and in the general population. The respiratory effects elicited by particulate matter containing manganese are not attributable to the concentration of manganese in the particulate matter. Exposure to particulate matter of any composition can be associated with an increased incidence of respiratory effects. An analysis of the health effects associated with exposure to particulate matter and the concentrations required to elicit those effects is contained in the EPA

staff paper (EPA 450/5-82-001) and the criteria document on particulate matter (EPA 600/5-82-029). The H&D also reports that five negative animal carcinogenicity studies have been conducted using routes of exposure other than ingestion or inhalation. No epidemiological studies have been conducted that associate manganese exposure with cancer in humans.

The principal sources of manganese air emissions are from steel production, iron and steel foundries, ferroalloy production, sewage sludge incineration, synthetic manganese dioxide production, dry cell battery production, fossil fuel combustion, cement production, and cooling towers when manganese compounds are used as biocides. Fossil fuel combustion, steel and ferroalloy production are the largest sources of manganese air emissions. These three source categories account for approximately 3600 metric tons of manganese per year of the estimated 4100 metric tons of manganese emitted from all the above sources.

In order to assess the potential for noncarcinogenic health effects to occur from ambient exposures to manganese, a preliminary analysis was conducted to determine if ambient manganese concentrations would be likely to exceed levels that could be associated with adverse health effects. The approach used in this analysis involved four steps. First, target protective levels were identified for both neurotoxic and respiratory effects. Second, manganese emissions from the major source categories were modeled to estimate both long-term and short-term concentrations of manganese. Next, total suspended particulate matter concentrations measured in the vicinity of selected manganese emitting facilities were obtained. Finally, the target protective levels were compared with the modeled manganese concentrations and the monitored particulate matter concentrations.

The target protective levels identified for respiratory effects were the primary NAAQS for particulate matter that were established to protect the public health with an adequate margin of safety. These levels were selected on the basis that the respiratory effects elicited by particulate matter containing manganese are identical to those elicited by particulate matter not containing manganese. The target protective levels identified for neurotoxic effects were those recommended by the World Health Organization (WHO) and the American Conference of Governmental Industrial Hygienists (ACGIH). These levels are

considered reasonable and conservative given that the H&D reports that neurotoxic effects have only been documented in workers chronically exposed to manganese concentrations around 5000 micrograms per cubic meter ($\mu\text{g}/\text{m}^3$) or higher. Protective levels were not identified for metal fume fever since this acute occupational hazard is confined to the immediate workplace and will not occur at ambient concentrations.

The modeling exercise used worst case meteorological conditions, in a conservative screening model and the most current emissions data available for each major source of manganese emissions. The highest manganese concentrations predicted by the model were $250 \mu\text{g}/\text{m}^3$ for 15-minutes and $125 \mu\text{g}/\text{m}^3$ for 8-hours. All of the modeled concentrations were well below the protective levels for comparable averaging times.

This conclusion is further supported by the fact that monitored total suspended particulate concentrations within three miles of three of the five currently operating ferroalloy facilities in the U.S. indicate that both the 24-hour and the annual NAAQS for particulate matter have been attained since at least 1981.

Neither the modeling or monitored results suggest that noncarcinogenic health effects would be expected from exposure to ambient concentrations of manganese associated with manganese emissions from industrial sources. Furthermore, ambient concentrations in the urban ambient air have decreased from an annual average of $0.11 \mu\text{g Mn}/\text{m}^3$ in 1953-1957 to $0.033 \mu\text{g Mn}/\text{m}^3$ in 1982.

The EPA has determined that no regulation directed specifically at manganese is necessary at this time under the Clean Air Act to protect the public health. Manganese sulfate is presently scheduled for carcinogenicity testing by the National Toxicology Program (NTP), using the oral route of exposure, with a projected completion date of September 1987. Preliminary mutagenicity studies conducted by NTP to date have not indicated any reason for concern. EPA will follow these activities as well as any future research, and will reinstitute assessment if warranted by the results of that research.

EPA's decision not to regulate manganese as a hazardous air pollutant has no effect on the regulation of particulate matter, which includes manganese. EPA has established NAAQS for particulate matter, under

section 106 of the Clean Air Act, to protect the public health and welfare.

Dated: August 2, 1985.

Lee M. Thomas,
Administrator.

References

- Anderson, M.E., T.L. Curtin and M.G. Smith (1984). Regulatory Options Analysis for Manganese—Draft Final Report. EPA Contract No. 80-02-3390. Prepared for the Pollutant Assessment Branch, Strategies and Air Standards Division, Office of Air Quality Planning and Standards, Research Triangle Park, North Carolina.
- EPA (U.S. Environmental Protection Agency) (1982). Review of the National Ambient Air Quality Standards for Particulate Matter: Assessment of Scientific and Technical Information (OAQPS Staff Paper). Office of Air Quality Planning and Standards, Research Triangle Park, N.C. EPA 450/5-82-001.
- EPA (U.S. Environmental Protection Agency) (1982). Air Quality Criteria for Particulate Matter and Sulfur Dioxides. Environmental Criteria and Assessment Office, Office of Research and Development, U.S. Environmental Protection Agency, Research Triangle Park, N.C. EPA 600/5-82-028.
- EPA (U.S. Environmental Protection Agency) (1984). Health Assessment Document for Manganese. Environmental Criteria and Assessment Office, Office of Research and Development, U.S. Environmental Protection Agency, Cincinnati, Ohio.
- RADIAN (1984). Study of Sources of Chromium, Nickel and Manganese Air Emissions—Final Report. Radco Corporation. EPA Contract No. 80-02-3018. Prepared for the Pollutant Assessment Branch, Strategies and Air Standards Division, Office of Air Quality Planning and Standards, Research Triangle Park, North Carolina.
- PATE, Nancy B. (1985). Preliminary Analysis of the Health Effects Associated with Manganese and Concentrations Predicted to be Present in the Ambient Air for Various Averaging Times. Memorandum to Files. EPA, Office of Air Quality Planning and Standards, Research Triangle Park, North Carolina 27711, June 7, 1985.

[FR Doc. 85-19198 Filed 8-13-85; 8:45 am]
BILLING CODE 6850-05-01

[ADL-PRL-2741-8]

Air Pollution Control; Assessment of Chlorinated Benzenes as Potentially Toxic

AGENCY: Environmental Protection Agency (EPA).

ACTION: Notice of intent not to regulate chlorinated benzenes under the Clean Air Act (CAA).

SUMMARY: This notice describes the results of EPA's preliminary assessment of chlorinated benzenes with respect to

Hand
noted



UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
ANN ARBOR, MICHIGAN 48105

OFFICE OF
AIR, NOISE AND RADIATION

August 16, 1985

Mr. Wolfgang Groth, Manager
Emissions Certification & Fuel Economy
Volkswagen of America, Inc.
293 East Liberty Plaza
P.O. Box 7050
Ann Arbor, MI 48107

Dear Mr. Groth:

Subject: Manganese Fuel Additive-Based Particulate Trap
Regeneration System

This letter responds to your August 23, 1984 request to certify 1986 and later model year vehicles using a manganese fuel additive for diesel particulate trap regeneration. Based on the information you have supplied, we have concluded the use of this system for the interim period of 1986 through 1988 model years would not pose an unreasonable risk to public health, welfare, or safety.

We are approving this on a limited basis because no studies have yet been conducted that address the potential harmful effects of manganese at the low ambient concentrations that would likely result from its use. For example, your worst-case dispersion model projects potential street canyon concentrations of manganese at 7.6 mg/m^3 if all vehicles were diesel and all used the manganese system, and if all manganese introduced to the system were emitted. In reality, however, the concentrations will be lower as a portion (at least 30 percent based on California Air Resources Board (CARB) data) of the manganese is retained on the particle filter and only a fraction (presently about 3% of new car sales) of the vehicle population is diesel-powered. Furthermore, it would take several years for fleet turn-over to occur. Therefore, actual concentrations could be more on the order of 0.14 mg/m^3 in street canyons after fleet stabilization. (Note: This assumes a future fleet portion of 3 percent diesel vehicles, all equipped with the manganese additive.) This level far exceeds the 1982 manganese concentration of urban areas of 0.033 mg/m^3 as measured by the National Air Surveillance Network, but it is far below any levels that have been used to determine adverse human health effects.

We have been in contact with representatives of Lubrizol Corporation. They have supplied copies of studies outlining Lubrizol 8220 oral toxicity, primary skin irritation, and primary eye irritation in animals. Results indicate that Lubrizol 8220 is not toxic in rats in tests by the oral route of administration and is not a primary skin irritant to rabbits. Lubrizol 8220 is, however, a possible primary eye irritant, based on a study using rabbits. A material safety data sheet supplied by Lubrizol states that "inhalation may cause respiratory irritation, dizziness, nausea and headache." These effects occur at higher exposure levels and it is not known with certainty what effects would occur at lower exposure levels to the additive or, more importantly, exhaust emission products from combustion of this additive. We are not aware of any inhalation studies in animals or threshold limit value established for humans for this product or its combustion products.

The Fraunhofer Institute report¹ which you have supplied amplifies the lack of information that exists in regard to Lubrizol in diesel trap oxidizers. The report states, "To date, no study is available giving a toxicological evaluation of Lubrizol. As expected under these circumstances, there is also no threshold limit value (TLV) announced for this Mn compound."² The report also states, "There are no studies available on the toxicity of Lubrizol 8220 or its combustion products."³

However, EPA has recently released a health assessment document for manganese in which the key health effects studies of manganese and manganese compounds have been summarized and evaluated. The key health effects of manganese are in the central nervous system and the lungs. Adverse, irreversible effects to the central nervous system result from chronic manganese poisoning, known as manganism. Exposure to levels as low as 1 mg/m³ have been associated with these effects. There is little supportive animal data.

Our temporary approval of the use of this system stems from the fact that one use of the system, in a small portion of the in-use fleet over the next few years, will have a negligible

1. Fraunhofer-Institut fuer Toxikologie and Aerosolforschung
Institutsteil Hannover/Muenster, Evaluation of Health
Effects Associated with the use of a Manganese Additive
in Connection with the Diesel Trap Oxidizer Regeneration,
Under Contract to Volkswagenwerk AG. Feb. 1984.

2. Ibid., p. 23.

3. Ibid., p. 25.

impact on current ambient manganese levels. As such, until Volkswagen can provide EPA with conclusive data on the long term health risks at various projected ambient levels, EPA cannot grant permanent approval under current policy and statute.

Our policy in this matter is outlined by Advisory Circular Nos. 76 and 76-1 (Subject: Compliance with the Requirements of Sections 202(a)(4) and 206(a)(3) of the Clean Air Act). The language of Sections 202(a)(4) and 206(a)(3) taken together make it clear that the burden is on the manufacturer to make the requisite showing that the emission control system will not cause or contribute to an unreasonable risk to public health, welfare or safety.

The finding of unreasonable risk requires a number of trade-offs. First, Section 202(a)(4)(B) explicitly indicates that relevant information on health effects of diesel particulates be considered. In other words, consideration of trade-offs between diesel particulate control and control of other unregulated pollutants is appropriate. There must be a comparative analysis of alternative competing technologies. There also has to be a "comparison among unregulated pollutant risks" and then a "balancing" of these factors.

The use of the words "cause or contribute" suggests that more is required than merely a showing that emissions of VW/Audi unregulated pollutants do not create an unreasonable risk. If, for example, there were the potential for an unreasonable risk posed by ambient concentrations of manganese from a number of sources, then any emissions increase could be found to contribute to that unreasonable risk. Again, whether a risk is unreasonable turns on a balancing of technological and health effects factors.

Considering the balancing of the technological and potential health effects, we have decided not to refuse initial certification of a potentially promising particulate control technology at this early stage. However, it is Volkswagen's responsibility to assure the necessary research is conducted. EPA will not authorize the certification of vehicles using manganese additives beyond the 1988 model year unless significant progress is made in conducting the research. We would expect the entire issue should be resolved in time to decide on a control strategy for the 1990 and later model years. To this end, Volkswagen should submit a detailed research plan to EPA by late this year or early next year. The plan should discuss all relevant health work in progress and give milestone dates when progress and final reports will be available. Keep in mind that EPA may re-evaluate its position

-4-

based on the results of health effects studies. We may also have to re-evaluate our position if the diesel vehicle sales fraction increases significantly.

Sincerely yours,

Thomas M. Bell

for Robert E. Maxwell, Director
Certification Division
Office of Mobile Sources

cc: J. German
C. Gray
P. Lorang
R. Wilson

Board of Directors
Archibald Cox,
Chairman
William O. Lister
Donald Kennedy
Charles W. Powers

Officers
Thomas P. Grumbly,
Executive Director
and Treasurer
Richard M. Cooper,
Secretary

HEALTH EFFECTS INSTITUTE

215 First Street
Cambridge, Massachusetts 02142
(617) 491-2926

Research Committee
Walter A. Rosenblath,
Chairman
Joseph D. Bron
Curtis C. Harris
Roger O. McClellan
Robert F. Sawyer
John W. Tukey
Mark J. Urell
Gerald N. Wagon

Review Committee
Robert I. Levy,
Chairman
Gareth M. Green
Millicent W. P. Higgins
Paul Meyer
Sheldon D. Murphy
Arthur C. Upton

October 7, 1985

Mr. Wolfgang Groth
Manager, Emissions and Fuel Economy
Volkswagen of America, Inc.
888 W. Big Beaver
P.O. Box 3951
Troy, Michigan 48067-3951

Dear Mr. Groth:

In a letter to the Health Effects Institute (HEI) dated June 29, 1984, Volkswagen Of America, Inc. requested that the HEI Health Research Committee undertake an evaluation of potential health issues related to emissions from diesel automobiles using manganese (Mn)-containing fuel additives for particulate trap regeneration. As indicated in our initial response of July 23, 1984, your request was brought to the Research Committee at its next meeting, which occurred in September 1984. Since then, significant work has been underway.

This letter summarizes the HEI's response to Volkswagen and includes a discussion of the known health effects of manganese in the context of increased ambient levels of Mn expected with implementation of the trap technology. Prior to the technical summary, we briefly discuss the statutory and institutional frameworks for our response and the process leading to this evaluation.

Framework and Process

The Volkswagen (VW) request is relevant to both compliance of automobile manufacturers with the Clean Air Act (CAA) and to the chartered role of the Health Effects Institute. Section 202(a)(4) of the Act states that "no emission control device, system or element of design shall be used in a new motor vehicle or new motor vehicle engine for purposes of complying with standards prescribed under this subsection if such device, system, or element of design will cause or contribute to an unreasonable risk to public health, welfare, or safety in its operation or function."

The manganese additive in question is a key ingredient in a new technology designed to lower diesel particulate emissions in

compliance with Federal and California State law. As such, this technology is covered by Section 202(a)(4) of the Clean Air Act. Volkswagen's concern to remain in compliance and its request to the HEI is appropriate.

The Health Effects Institute operates under the joint sponsorship of the Environmental Protection Agency (EPA) and the motor vehicle industry to support health research on automotive emissions. The HEI undertakes research and evaluations in an attempt to develop an objective and commonly accepted database. In a letter dated March 20, 1984 to all motor vehicle and engine manufacturers, Joseph Cannon, the EPA Assistant Administrator for Air and Radiation, and Bernard Goldstein, the EPA Assistant Administrator for Research and Development, jointly reaffirmed the Health Effects Institute as "the primary mechanism through which participating motor vehicle manufacturers discharge their health testing responsibilities under Section 202(a)(4) of the Clean Air Act." They further urged "that unregulated emissions of potential importance be brought to the Health Effects Institute's attention in a timely manner."

In order to meet its obligation to its sponsors, and fulfill its role in helping to implement Section 202(a)(4) of the Clean Air Act, the HEI conducted an evaluation of manganese under the supervision of the Health Research Committee. In its September 1984 meeting, the Committee discussed the VW request and received a preliminary briefing on the toxicology of manganese from Dr. Carl Shulz (COSAR, Inc.). The Committee accepted the VW request and decided that further analyses were necessary to determine if the tailpipe emissions of Mn were of public health concern and whether the HEI should sponsor research in this area. Following this meeting, the HEI commissioned Roth Associates (Dr. Neil Roth, PI) to conduct an in-depth review of the relevant literature on manganese. This review included actual replication of Volkswagen's modeling predictions on potential Mn-exposure levels from the regenerator, additional modeling of other emission scenarios not analyzed by VW, plus analyses of the health effects literature. The Committee evaluated all of this information at its June 1985 meeting. A final review of the information in this letter was conducted at the Committee's meeting on September 26, 1985.

Summary of Evaluation

The evaluation first places projected Mn emissions in the context of ambient Mn levels across the United States, and then examines the health literature on Mn to establish whether the expected incremental levels of airborne Mn from regenerator-equipped automobiles are of health-related concern. Finally, we identify a number of areas in which our knowledge concerning exposure and potential effects can be improved.

To summarize our findings, increased air concentrations of Mn resulting from the use of VW's particle trap will not, under

any realistic scenario, reach the lowest concentrations that have been reported in the literature to be associated with adverse chronic health effects. Despite this conclusion, certain gaps remain in our knowledge of Mn emissions and effects. These gaps primarily involve the particle size distribution and chemical species (e.g., MnO_2 , Mn_3O_4) in which Mn is emitted and how they might affect toxicity. The gaps in emissions characterization are best dealt with by the manufacturers directly as more experience is obtained.

Manganese: Ambient Levels and Automobile Emissions

Manganese is the twelfth most abundant element on earth, and is found mainly in oxide or carbonate form as a natural constituent of soil and water. As such, Mn is a component of background aerosol that winds, waves, and other natural processes generate. Manganese is also found in a wide variety of foods (Table 1), and is considered essential for normal health. Food accounts for at least 98% of an adult person's intake of manganese (2-9 mg Mn/day) with practically all the remainder in drinking products; inhalation, in all but the most polluted occupational settings, contributes negligibly to the body burden of Mn.

Monitoring of ambient manganese in the United States started in 1953. As a general trend, Mn levels have decreased since that time and have remained relatively stable since 1972. Improved industrial control processes are believed to account for much of the decrease. Quarterly data collected by the National Air Surveillance Network (NASN) show that between 1972 and 1982 in urban sites, the highest median level of Mn for any year was 0.034 ug Mn/m^3 (1978), and the highest 95th percentile level was 0.12 ug Mn/m^3 (1972); corresponding values for nonurban NASN sites are a median of 0.009 ug Mn/m^3 (1977) and 95th percentile of 0.030 ug Mn/m^3 (1976, 1977).¹⁰ These data, though valuable, are regional and tend to obscure the higher local Mn levels that may result, for example, from industrial activity, quarrying processes, or farming. For example, near foundries, Mn levels can typically reach 0.3 ug/m^3 , and near ferromanganese plants, they can exceed 1 ug/m^3 . EPA Storage and Retrieval of Aerometric Data (SAROAD) collected from 1980 to 1982 (Table 2) show that many areas experience peak 24-hour Mn levels in excess of 0.1 ug/m^3 , and that locations in three states (Indiana, Maryland, and Pennsylvania) registered mean 24-hour averages greater than 0.1 ug Mn/m^3 .

The highest exposures to airborne manganese occur occupationally in mining operations, ore processing plants, and ferromanganese plants (Table 3). The levels in these settings may be a thousand times or more greater than the higher ambient urban levels discussed earlier. In recognition of the potential toxicity of manganese at these extreme occupational levels, workplace standards have been set (Table 4). The World Health Organization's is the most conservative at 300 ug Mn/m^3 time-

weighted average. In interpreting the meaning of this level, it is important to bear in mind that a workplace standard applies to a workforce that is presumed healthy and more resilient to environmental insult than the population at large. Workplace standards are not applicable to the general public, and should not be construed as protective of the public's health.

Without the use of manganese fuel additives, the contribution of motor vehicle emissions to ambient manganese levels is probably very small. In the 1970's, MMT, a Mn-containing additive was included in some unleaded gasolines to improve octane ratings. Consequently, some efforts were taken to estimate and measure the increased Mn concentrations in air associated with the additive's use. Ter Haar et al (1975) estimated that the mean urban increment would be 0.05 ug Mn/m^3 with a peak of 0.25 ug Mn/m^3 if MMT was in all vehicles and fuel concentrations of Mn were 0.125 g/gal .⁹ Pierson et al (1978) with the use of aerosol sampling, determined Mn levels in the Allegheny and Tuscarora Tunnels of the Pennsylvania Turnpike for several one-week intervals between 1975 and 1977.¹⁰ (In this period, the use of MMT was at its peak; however, in 1978, the use of MMT as an additive to unleaded gasoline was terminated.) The highest average weekly level inside the tunnels was 0.13 ug Mn/m^3 , and the average for the measurement periods was 0.11 ug Mn/m^3 . The peak use of MMT during the study (1977) resulted in an average value of 16 mg Mn per gallon of gasoline in vehicles coursing through the tunnels; corresponding Mn-emission rates were 0.13 mg Mn/mile . These data suggest that in locations with a heavy flow of traffic emitting MMT-derived manganese into a confined space, increased manganese levels at roadside may be discriminated from background levels. One of the important unknowns, and a possible confounding factor in roadside measurements, is the extent to which traffic resuspends road dusts that contribute to the manganese content of the roadside aerosol.

Volkswagen has proposed to equip its diesel automobiles with a particle regenerator system that uses Lubrizol 8220, a manganese-containing additive. The system is designed to help model 1986 and future automobiles comply with U.S. and California regulations for particulate emissions. The emission rates of manganese from vehicles so equipped are expected to be considerably higher than those associated with MMT use. For highway driving, VW estimates that emission rates will range from an expected value of 1.38 mg Mn/mile to a worst-case value of 4 mg Mn/mile ; For street driving, expected emissions will be 3.13 mg Mn/mile with a worst-case value of 10 mg Mn/mile .^{17,18} (VW had previously estimated that conservatively, Mn emissions from MMT could be 0.58 mg Mn/mile .⁵) The worst-case numbers are based on the assumption that all of the manganese metered into the fuel stream is emitted while the expected values reflect realistic Mn retention in the engine and particle filter.

Volkswagen has used modeling techniques to project these emission rates into manganese concentrations at the side of freeways and within street canyons. Assuming 100% penetration of the regenerator into the automobile fleet, worst-case traffic conditions, and a crossroad wind, VW calculated, using the EPA HIWAY-2 model, the Mn concentrations indicated in Table 5.

The data obtained from such modeling calculations are necessary and important for placing the health questions in the perspective of expected human exposure. The necessity derives from the fact that direct measurements of manganese are not now possible since the technology is not yet implemented in the active fleet. The modeling results are important because they help anticipate whether situations may arise in which manganese concentrations achieve levels that are associated with known health effects. Given these considerations, the HEI felt it appropriate to independently verify the results from the HIWAY-2 model. The HEI analyses basically agree with VW's results except that, for highways, the most conservative values occur with the wind parallel to the roadway (Table 6). With a parallel wind (5 degrees to the roadway) VW's worst-case highway Mn level would be 3.60 ug Mn/m^3 instead of 2.00 ug Mn/m^3 .

These modeling exercises produce ceiling estimates based on hypothetical situations. These estimates serve a valuable purpose in that, once accepted, they provide a reference for applying correction factors. Perhaps the most important correction factor involves fleet penetration of the manganese technology. The California Air Resources Board (CARB) estimates that by 1990, between 2.6% and 6.6% of the vehicle fleet will have particle traps (values derived from reference #1, Table 1). Thus, for 1990, one may adjust the worst-case street canyon value of 7.6 ug Mn/m^3 to between 0.2 and 0.5 ug Mn/m^3 for upper-bound emission rates of 10 mg Mn/mile , and to between 0.06 and 0.16 ug Mn/m^3 for expected emission rates of 3.13 mg Mn/mile . Likewise, for highways with parallel winds, Mn values at roadside will be between 0.09 and 0.24 ug Mn/m^3 for upper-bound emission rates of 4 mg Mn/mile , and between 0.03 and 0.08 ug Mn/m^3 for expected emission rates of 1.38 mg Mn/mile .

It seems highly unlikely, therefore, that, under the conditions described, automobiles equipped with the proposed particle regenerator system will contribute more than 1 ug Mn/m^3 to ambient air. A number of factors, however, still require attention to provide a more complete picture of manganese emissions from these automobiles. At present there is no information on the size distribution of Mn-containing particles in the exhaust or the species of manganese compounds that are emitted. Also, the modeling performed to date does not consider the mode of vehicle operation such as acceleration and steady state driving. If the properties of Mn emissions are similar to those of lead, then the percentage of Mn exhaust may vary with the vehicle operating condition and will increase when vehicles accelerate from a stop or a low cruise (20 mph) to a much higher

speed (60 mph). This occurs because particles can build up in the exhaust system during steady state driving and are released during high load accelerations. If this is the case, then the roadside levels of Mn at a section of road where vehicles accelerate will be higher than the above calculations indicate.

Health Effects of Manganese

At present, there is no indication that health effects are associated with chronic exposures of less than 2 ug Mn/m^3 , a value we believe exceeds the highest ambient levels expected with use of the regenerator. The effects of greatest concern are neurotoxic and respiratory and these have been reported over the past several decades in studies of occupational exposure to manganese. There are no studies which have investigated whether inhaled manganese is carcinogenic in laboratory animals or human beings. Manganese administered by subcutaneous, intraperitoneal, or intramuscular routes has induced tumors in some studies but not in others (reviewed in reference #12). Inhalation studies have concentrated primarily on neurotoxic and respiratory effects.

Neurotoxicity: The neurotoxic effects in humans require at least several months of exposure and progress from an early reversible stage characterized by psychological disturbances to a more advanced and irreversible stage marked by a neuropathy that has been labeled manganism. This condition resembles Parkinsonism in its overt manifestations of a motor disorder, and like Parkinson's disease, does involve neural pathways in the brain that utilize the neurochemical transmitter, dopamine. However, the specific regions of the brain relevant to each of the two diseases are different.

The human clinical and epidemiologic literature suggests that neurotoxicity is not strongly indicated until exposure exceeds 5 mg Mn/m^3 (or $5,000 \text{ ug Mn/m}^3$), but that neurological symptoms may occur at levels as low as 0.3 mg Mn/m^3 (300 ug Mn/m^3). A possible exception is a study in which Saric et al (1977) compared neurologic symptoms among workers in a ferroalloy plant ($0.3\text{--}20.4 \text{ mg Mn/m}^3$), an electrode plant ($2\text{--}30 \text{ ug Mn/m}^3$) and an aluminum rolling mill ($0.05\text{--}0.07 \text{ ug Mn/m}^3$), the last to serve as a control. Their findings show an excess of symptoms in the ferroalloy plant and a smaller excess in the electrode plant, suggesting an effect between 2 and 30 ug/m^3 . This study, however, suffers from serious inadequacies. The symptom of major importance in the electrode plant, tremor at rest, is not attributable solely to manganese and possible confounding factors were not studied. Secondly, a number of subjective symptoms did not follow a dose-response relation across the three plants, and also failed to do so when the ferroalloy cohort was sub-divided into three exposure groups. Finally, statistical analyses of the published data were conducted for the HEI (Roth Assoc.) and show that smoking alone may explain the differences in symptoms between plants.

Animal studies shed little additional light on the subject. Only two studies have attempted to study neurological or behavioral effects following inhalation of manganese aerosol. In neither case were effects reported in monkeys at concentrations of Mn_3O_4 ranging over $1mg/m^3$.^{1,14-16}

Respiratory Toxicity: The respiratory effects of manganese involve an inflammatory effect or pneumonitis, which may lead to diminished pulmonary function, bronchitis, or altered susceptibility to infection. The animal research literature suggests that chronic pulmonary effects may occur between 100 and 700 ug/m^3 . As with the research on neurotoxicity, the literature is limited and difficult to extrapolate to manganese emissions from automobiles.

The U.S. EPA, in its Health Assessment Document for Manganese, considers respiratory symptoms to be the "critical effect" for manganese because respiratory effects are reported at levels lower than those reported for neurotoxicity. Based on studies in rats and monkeys, the EPA calculated Human Equivalent Exposure Levels (HEEL) for studies indicating No Observed Effect Levels (NOEL) and the Lowest Observed Adverse Effect Level (LOAEL). After applying a correction factor of 10 to account for potentially sensitive individuals, the EPA derived a human equivalent NOEL of 5 $ug Mn/m^3$ based on rats and 8.7 $ug Mn/m^3$ based on monkeys; the LOAEL, based on monkeys is 36.5 $ug Mn/m^3$.¹³

These levels are much lower than those associated with respiratory effects in occupational settings. The studies of workers exposed to manganese generally show that respiratory effects follow exposures in excess of 5 $mg Mn/m^3$. There are data, however, from a Japanese study (Nogawa et al, 1973) of junior high school students that apparently associate increased respiratory symptoms and diminished pulmonary function with manganese levels in the NOEL-LOAEL range that EPA calculated.⁶ The major variable in the study was proximity of the student's school to a source of ambient manganese. The source was a ferromanganese plant and the students classified as "exposed" attended a school 100 meters from the plant. Students in a school 7 km from the plant served as controls. Relative exposure of the two groups to manganese was primarily determined by the amount of manganese in the dustfall at the two locations. The investigators estimate that exposure near the plant was 20 or more times higher near the plant than at the control site. Air samples that were taken 100 m from the plant indicated airborne manganese concentrations of 4 $ug Mn/m^3$. EPA estimated, on the basis of analyses of dustfalls near a ferromanganese plant in the Kanawha Valley in West Virginia, that the dustfall in the Nogawa study may translate to between 3 and 11 $ug Mn/m^3$.¹¹

Although participation of the student bodies in the survey was nearly complete, several problems remain which prevent this study from being conclusive. First, dustfall was used by the investigators as the principal index of exposure rather than

direct air sampling. It is thus difficult to ascertain the amount of dust that, when suspended, contained respirable manganese. The quality of exposure information, therefore, is less than desirable. Also, the authors failed to adjust for potential socio-economic factors. Frequently, poorer populations with inferior health and medical care are located in more heavily polluted areas. Associated environmental conditions may include increased crowding at home and increased exposure to indoor pollutants, particularly, cigarette smoke. Such factors may bias resulting health data and produce inappropriate conclusions. Furthermore, pulmonary function was not tested in a blind fashion, nor did the investigators appear to have a full appreciation of the difficulty in administering pulmonary function tests to school children. In addition, there are problems with the study's medical questionnaire, an adaptation of the British Medical Research Council's Questionnaire (1966 version). It primarily probed for subjective responses, an approach that is difficult to control even in studies of adults.

Thus, despite the relevance of the exposure levels in this study to worst-case manganese levels expected from automobile emissions, we believe the data are subject to question. Nonetheless, the study stands as the only one on record that addresses potential chronic effects of low levels of manganese in a potentially sensitive segment of the non-occupationally exposed population. The criticism given above suggest that the study suffers from methodologic deficiencies, but they do not invalidate the reported results. The ambient concentrations of manganese apparently associated with respiratory effects in this study are, according to estimates and limited measurements, 3 to 4 times higher than the the maximum concentrations expected from diesel automobiles under realistic scenarios. However, there are no epidemiologic data from the general population that have examined for respiratory effects at lower levels.

Conclusion

The available data do not indicate that currently anticipated levels of manganese emissions from diesel automobiles using Lubrizol 8220 are associated with increased public health risks. It appears unlikely that implementation of the regenerator, as currently proposed by Volkswagen, will result in an increase of more than 1 ug Mn/m^3 in ambient air; airborne manganese concentrations from other sources rarely exceed 0.1 ug Mn/m^3 . Inhaled manganese is capable of producing health effects, specifically neurotoxic and respiratory, but none of these have been demonstrated at the maximum ambient levels expected with implementation of the trap technology into the light duty fleet. Despite an apparent margin of safety between maximally expected manganese concentrations and the lowest levels at which effects may occur, additional information is necessary to reinforce a conclusion that no health effects are expected.

We presently lack data on the size distribution of particles emitted from the tailpipe and the amount and species of manganese they contain. According to VW analyses, the manganese is likely to be in oxide form (e.g., MnO_2 , Mn_2O_3), but measured values of species-specific manganese levels in diesel exhaust are not yet available. These data are important because particle size distribution helps predict the extent and region of pulmonary particulate deposition, and a description of the chemical form of emitted manganese is important in case its toxic effects are a function of its valence state. The Health Research Committee believes that Volkswagen must continue its efforts to characterize tailpipe emissions over a range of engine operating modes, and to communicate the data to all interested parties.

As discussed in this letter, the data base on the health effects of manganese is not as complete as one would prefer. Because manganese is essential for normal health, it is reasonable to expect that there are threshold levels below which health effects are not expected. The range of that threshold and how it may vary for different subpopulations are not currently known with any accuracy. With the exception of the study by Nogawa et al, the available evidence does not implicate manganese in adverse effects until it achieves levels between 100 and 1000 micrograms per cubic meter; using CARB estimates for fleet penetration of the trap technology, ambient levels of Mn will remain below 1 $\mu\text{g Mn/m}^3$. As mentioned, the Nogawa study cannot be overlooked despite its methodological problems, and perhaps a reanalysis of the study design and raw data would clarify its results.

* The EPA issued a decision on August 13, 1985 not to regulate manganese as a hazardous air pollutant under Section 112 of the Clean Air Act.⁴ However, the Agency also intends to continue to monitor research activities, "and will reinstitute assessment if warranted by the results of that research." The Health Effects Institute endorses such flexibility and stands ready to reevaluate this issue as new relevant scientific and engineering data emerge or the use of the manganese technology expands beyond currently anticipated levels.

Please feel free to contact the HEI if you have further questions concerning the issues in this letter or any new concerns that may arise. We thank you for your interest.

Sincerely,

Thomas P. Grumbly
Executive Director

cc: HEI Health Research Committee
Mr. Stanley Blacker

REFERENCES

1. California Air Resources Board, Memorandum-"Modeling Analysis of Potential Impacts of Manganese as a Diesel Fuel Additive", Sacramento, CA, September 28, 1984.
2. Cooper, W.C. 1984. The health implications of increased manganese in the environment resulting from the combustion of fuel additives: A review of the literature. *J. Toxicol. Environ. Health* 14:23-46.
3. Coulston, F., and Griffin, T. 1970. Inhalation toxicology of airborne particulate manganese in rhesus monkeys. Institute of Comparative and Human Toxicology, International Center of Environmental Safety, Albany Medical College, Holloman Air Force Base, New Mexico. EPA Contract No. 68-02-0710. (Also EPA-600/1-77-026, May 1977.)
4. Environmental Protection Agency. Decision Not to Regulate Manganese Concentrations as Hazardous Air Pollutant Under Section 112 of Air Act. *Federal Register* 50: 32627-32628, August 13, 1985.
5. Fraunhofer-Institut für Toxikologie und Aerosolforschung Institutsteil, Hannover/Münster. Evaluation of Health Effects Associated with the Diesel Trap Oxidizer Regeneration, A Literature Search. Under contract with Volkswagenwerk AG. February 1984. p.13.
6. Nogawa, K., Kobayashi, E., Sakamoto, N., Fukushima, N., Ishizaki, A., Makino, N., Kagamimori, S., Hiramaru, Y., Kawano, S., Kato, T., Kanekawa, KJ., Shozo. 1973. Studies of the effects on the respiratory organs of air pollution consisting of dusts composed mainly of manganese. (First Report) Effects on the respiratory organs of junior high school students. *Nippon Koshu Eisei Zasshi* (Jap. J. Public Health) 20:315-325.
7. Pierson, W.R., McKee, D.E., Brachaczek, W.W., and Butler, J.W. 1978. Methylcyclopentadienyl manganese tricarbonyl: Effect on manganese emissions from vehicles on the road. *J. Air Pollut. Control Assoc.* 28:692-693.
8. Saric, M., Markicevic, A., and Hrustic, O. 1977. Occupational exposure to manganese. *Br. J. Ind. Med.* 34: 114-118.
9. Ter Haar, G.L., Griffing, M.E., Brandt, M., Oberding, D.G., and Kapron, M. 1975. Methylcyclopentadienyl manganese tricarbonyl as an antiknock: Composition and fate of manganese exhaust products. *J. Air Pollut. Control Assoc.* 25:858-860.

10. United States Environmental Protection Agency, Environmental Criteria and Assessment Office. Health Assessment Document for Manganese. Final Report. EPA-600/8-83-013F. August 1984. pp. 3-67 to 3-68.
11. Ibid p. 6-52.
12. Ibid pp. 7-1 to 7-11.
13. Ibid pp. A-1 to A-5.
14. Ulrich, C.E., Rinehart, W., and Busey, W. 1979. Evaluation of the chronic inhalation toxicity of a manganese oxide aerosol. I. Introduction, experimental design and aerosol generation methods. Am. Ind. Hyg. Assoc. J. 40:238-244.
15. Ulrich, C.E., Rinehart, W., Busey, W., and Dorato, M.A. 1979. Evaluation of the chronic inhalation toxicity of a manganese oxide aerosol. II. Clinical observations, hematology, clinical chemistry and histopathology. Am. Ind. Hyg. Assoc. J. 40:322-329.
16. Ulrich, C.E., Rinehart, W., and Brandt, M. 1979. Evaluation of the chronic inhalation toxicity of a manganese oxide aerosol. III. Pulmonary function, electromyograms, limb tremor, and tissue manganese data. Am. Ind. Hyg. Assoc. J. 40:349-353.
17. Volkswagen, Manganese Concentrations in Air Resulting from the Possible Use of Manganese Compounds as a Diesel Fuel Additive and Health Effect Aspects of Manganese, Wolfsburg, West Germany, March 13, 1984.
18. Wiedemann B., and Neumann, K.H. 1985. Vehicular experience with additives for regeneration of ceramic diesel filters, Volkswagenwerk AG, Wolfsburg, West Germany, SAE Technical Paper Series No. 850017, Warrendale, PA.

Table 1
Manganese in Foods^a

Food	Manganese (wet weight, µg/g)	Food	Manganese (wet weight, µg/g)
Whole wheat, seed	11.32	Raisins, package	4.68
Bread, white	1.78	Apple	0.31
Bread, whole wheat	1.43	Orange	0.35
Oatmeal	2.72	Peach	1.02
Corn meal	2.05		
Macaroni, dry	10.56	Pecans	35.09
Grapenuts	30.76	Peanuts, salted	6.91
Milk, whole	0.19	Spinach, fresh	7.77
Milk, dry skimmed	0.00	Beets, fresh	0.41
Butter	0.96	Beans, canned	0.24
Eggs, whole	0.53	Peas, fresh	0.64
		Tomatoes, canned	0.30
Beef, roasting	0.05		
Lamb chops, lean	0.34	Black pepper	47.48
Chicken breast	0.21	Cloves	262.86
		Garlic powder	0.45
Halibut steak	0.12	Coffee, ground	20.65
Scallops, fresh	0.11	Coffee, infusion	0.35
Clams, fresh frozen	0.00	Tea, leaves	175.58
		Tea, infusion	6.9
Cod liver oil	4.95		
Corn oil	1.00		
Safflower oil	0.00		

^aSelected from Schroeder et al. (1966), Table 6, pp. 551-552.

from Cooper, 1984

Table 2

Ambient Manganese Concentrations by State from EPA's SAROAD Data

State	Number of Samples	1980-1982 SAROAD Data ($\mu\text{g}/\text{m}^3$) (24 hour averages)		Site Characteristics*
		range	mean	
Alabama	164	0-0.360	0.065	urban/suburban - Birmingham
	30	0.005-0.046	0.028	urban, rural
Arizona	1214	0-0.220	0.059	urban, rural
	64	0.003-0.070	0.025	rural, urban
	38	0-0.011	0.003	national park
Arkansas	27	0.002-0.038	0.009	national forest
	27	0.009-0.037	0.019	urban/suburban
California	65	0-0.080	0.028	rural/suburban, national forest
	97	0.004-0.060	0.024	urban, national forest/desert
	104	0-0.050	0.020	urban, rural
	78	0-0.070	0.025	urban - Los Angeles, San Francisco
Colorado	290	0-0.170	0.057	urban, rural
	79	0-0.060	0.028	national forest, rural, urban
	54	0-0.180	0.077	rural, national forest
	57	0-0.030	0.005	national forest
Connecticut	25	0.003-0.026	0.015	urban, rural
Delaware	21	0.002-0.050	0.018	urban/suburban
DC	24	0.010-0.032	0.019	urban
Florida	110	0-0.030	0.007	Everglades/ national park, urban
	206	0-0.032	0.011	urban, rural
Georgia	49	0-0.107	0.025	urban/suburban
	55	0-0.051	0.016	military reservation

Table 2 (continued)

Ambient Manganese Concentrations by State from EPA's SAROAD Data

State	Number of Samples	1980-1982 SAROAD Data ($\mu\text{g}/\text{m}^3$) (24 hour averages)		Site Characteristics ^a
		range	mean	
Hawaii	107	0-0.024	0.006	urban/suburban, national park
Indiana	77	0.004-0.103	0.019	urban
	164	0-0.045	0.024	rural, urban
	58	0.009-0.759	0.151	rural, urban - Gary
Iowa	142	0-0.130	0.034	rural, urban
Kansas	84	0.008-0.097	0.037	urban, rural - Kansas City - Topeka
Kentucky	66	0.004-0.299	0.042	suburban, rural
	41	0.009-0.133	0.047	rural
	354	0-0.182	0.026	urban
Louisiana	131	0-0.039	0.017	urban
	70	0.004-0.081	0.029	suburban
	36	0-0.021	0.009	rural
Maryland	21	0.018-0.261	0.107	urban - Baltimore
	25	0.010-0.220	0.069	urban, rural - Baltimore Co.
Massachusetts	42	0-0.029	0.010	urban
	28	0.006-0.032	0.017	rural
Michigan	35	0.004-0.050	0.017	rural
	46	0-0.140	0.036	urban/suburban - Flint
Minnesota	25	0-0.050	0.022	urban/suburban
Mississippi	25	0.007-0.058	0.023	urban, rural

Table 2 (continued)

Ambient Manganese Concentrations by State from EPA's SAROAD Data

State	Number of Samples	1980-1982 SAROAD Data ($\mu\text{g}/\text{m}^3$) (24 hour averages)		Site Characteristics ^a
		range	mean	
Montana	98	0-0.190	0.026	rural, urban
	78	0-0.080	0.029	national forest
	146	0-0.350	0.065	national forest, suburban/ military reservation
Nebraska	40	0.005-0.073	0.029	urban/suburban
Nevada	46	0.004-0.041	0.019	national forest, urban - Las Vegas
	114	0-0.066	0.015	forest, mountains
New Jersey	189	0-0.129	0.024	urban/suburban
New Mexico	43	0.007-0.069	0.031	urban
New York	45	0.002-0.079	0.023	rural/suburban, state park
	314	0-0.580	0.029	urban/suburban
North Carolina	48	0-0.0284	0.004	national forest
	133	0-0.071	0.015	urban, rural
Ohio	34	0.018-0.183	0.073	urban - Cleveland
	46	0-0.050	0.020	urban - Toledo, rural
	291	0-0.170	0.036	urban/suburban
	23	0.003-0.173	0.045	suburban, rural
Oklahoma	39	0.005-0.061	0.022	rural, suburban
	41	0.005-0.035	0.017	urban/suburban
Pennsylvania	58	0.010-0.960	0.120	urban - Philadelphia
	22	0.004-0.040	0.019	urban, rural
	65	0.005-0.184	0.049	rural, suburban

Table 2 (continued)

Ambient Manganese Concentrations by State from EPA's SAROAD Data

State	Number of Samples	1980-1982 SAROAD Data ($\mu\text{g}/\text{m}^3$) (24 hour averages)		Site Characteristics*
		range	mean	
South Carolina	132	0-0.039	0.013	rural, urban
South Dakota	30	0-0.010	0.005	national forest
Tennessee	111	0.003-0.070	0.028	urban
	72	0.005-0.290	0.051	national forest, rural - Sullivan County
	115	0.002-0.190	0.052	rural, urban
Texas	1519	0-0.457	0.021	urban/suburban
	339	0-0.072	0.015	rural
	636	0-0.343	0.023	suburban
	805	0-0.397	0.022	rural, urban
Virginia	48	0-0.027	0.006	national forest
	45	0-0.026	0.011	urban, rural
	21	0-0.014	0.007	urban - Danville
	130	0-0.050	0.017	urban/suburban
Washington	207	0-0.129	0.027	national forest, rural, urban
West Virginia	22	0.010-0.090	0.036	rural, urban
Wisconsin	49	0-0.020	0.005	rural
	94	0.004-0.255	0.044	urban/suburban - Milwaukee
	80	0-0.140	0.021	rural, urban
Wyoming	24	0-0.010	0.002	national forest

* Site characteristics are listed in order of predominance.

Table 3

**Examples of Levels of Occupational Exposure
to Airborne Manganese^a**

Operation	Range of averages ^b ($\mu\text{g Mn/m}^3$)	Range of peak levels ^b ($\mu\text{g Mn/m}^3$)	References
Ore crushing mill	10,400-173,000	—	Flinn et al. (1940)
Ore crushing	62,500-250,000	—	Ansola et al. (1944)
Potassium permanganate manufacture	300-250,000	—	Lloyd Davies (1947)
Mining, mine #1	187,000-926,000	—	Rodier (1955)
Mining, mine #2	65,000-814,000	—	Rodier (1955)
Mining, 1954	500-16,300	—	Schuler et al. (1957)
Mining, 1955	1,800-46,000	—	Schuler et al. (1957)
Ferromanganese production	2,300-4,700 ^c	—	Whitlock et al. (1966)
Mn ore processing	5,030-11,100	5,250-31,500	Tanaka and Lieben (1969)
Ferromanganese production	1,600-8,600	4,430-20,130	Tanaka and Lieben (1969)
Dry battery manufacture	6,800-42,200	—	Emara et al. (1971)
Ferromanganese production			
Old preparation plant	27,000-1,122,000	52,000-1,750,000	Smyth et al. (1973)
Blast furnace and pig casting ^d	120-13,300	1,900-206,000	Smyth et al. (1973)
Mn processing	2,100-12,900	5,000-61,500	Smyth et al. (1973)
* Ferroalloy production	301-20,440	—	Šarić et al. (1977)
Ferromanganese production (after controls)			
Blast furnace cast house ^d	230-820	1,100-22,600	Ruhf (1978)
Pig casting	390-620	3,960-5,200	Ruhf (1978)
Aln processing	390-2,260	1,000-24,300	Ruhf (1978)

^aAll studies prior to 1978 were associated with evidences of manganese toxicity in some individuals.

^bMethods of sample collection differ, i.e., thermal precipitation, electrostatic precipitation, millipore filter sampling.

^cValues later found to be too low.

^dF = fume.

from Cooper, 1984

Table 4

Guidelines and Standards for Manganese in the Workplace^a

Source	Applicable dates	Guideline or standard
ACGIH TLV	1946-1959	6000 $\mu\text{g}/\text{m}^3$ (TWA)
	1960-1962	5000 $\mu\text{g}/\text{m}^3$ (TWA)
	1963-	5000 $\mu\text{g}/\text{m}^3$ (Ceiling value)
	1978-	1000 $\mu\text{g}/\text{m}^3$ (TWA for Mn tetroxide)
	1979-	1000 $\mu\text{g}/\text{m}^3$ (TWA for Mn fume)
		3000 $\mu\text{g}/\text{m}^3$ (STEL for Mn fume)
OSHA	1972-	5000 $\mu\text{g}/\text{m}^3$ (Ceiling value)
WHO	1980-	300 $\mu\text{g}/\text{m}^3$ (TWA)

^aAbbreviations: ACGIH, American Conference of Governmental Industrial Hygienists; OSHA, Occupational Safety and Health Administration; WHO, World Health Organization; TLV, threshold limit value; TWA, time-weighted average; STEL, short-term exposure level.

from Cooper, 1984

Table 5

RESULTS OF VOLKSWAGEN MODELING

Roadway	Emission rates (mg Mn/mi)	Roadside concentration (ug Mn/m ³)
Highway	4.00	1.98
	1.38	0.64
Street Canyon	10.00	7.60
	3.13	2.20

Table 6

ESTIMATED AMBIENT Mn CONCENTRATIONS
DOWNWIND OF A HIGHWAY
(100% penetration)

Wind Direction to Roadway	Emission Rates	Estimated Concentrations	
	(mg Mn/mile)	4m Dwnwd	100m Dwnwd
		(ug Mn/m ³)	
Volkswagen Analysis			
90°	4.00	1.98	0.84
90°	1.38	0.64	0.22
HEI Analysis			
90°	4.00	2.00	0.80
90°	1.38	0.68	0.29
45°	4.00	2.50	1.20
45°	1.38	0.87	0.39
5°	4.00	3.60	2.50
5°	1.38	1.14	0.87

IS ACCURATE TO THE BEST OF SELLER'S KNOWLEDGE. HOWEVER, SELLER MAKES NO WARRANTY WHATSOEVER, EXPRESSED, IMPLIED OR OF MERCHANTABILITY REGARDING THE ACCURACY OF SUCH DATA OR THE RESULTS TO BE OBTAINED FROM THE USE THEREOF. SELLER ASSUMES NO RESPONSIBILITY FOR INJURY TO BUYER OR TO THIRD PERSONS OR FOR ANY DAMAGE TO ANY PROPERTY AND BUYER ASSUMES ALL SUCH RISKS.

MATERIAL SAFETY DATA SHEET

NPVLA 6-70

(Approved by U. S. Department of Labor "Essentially Similar" to form L58-005-4)

Section I

MANUFACTURER'S NAME	
THE LUBRIZOL CORPORATION	
STREET ADDRESS	
79400 Lakeland Blvd.	
CITY, STATE, AND ZIP CODE	
Mckinstry, Ohio - 44097	
EMERGENCY TELEPHONE NO.	
216/943-4200	
CHEMICAL NAME AND SYNONYMS	TRADE NAME
	LUBRIZOL 8220
CHEMICAL FAMILY	FORMULA

Section II - HAZARDOUS INGREDIENTS

PAINTS, PRESERVATIVES, & SOLVENTS

PIGMENTS	%	TLV (U/min)	SOLVENTS	%	TLV (U/min)
CATALYST			ADDITIVES		
THICKER			OTHERS		

HAZARDOUS MIXTURES OF OTHER LIQUIDS, SOLIDS, OR GASES

COMBUSTIBLE:		TLV (U/min)
Product contains Xylene. (Xylene contains 0.1% benzene)		
Product contains aromatic hydrocarbon solvent		
Product contains <u>aromatic compound</u> <u>ONE</u> ?		See/m

Section III - PHYSICAL DATA			
BOILING POINT (°F)	Not Determined	SPECIFIC GRAVITY (H ₂ O=1) @ 15.5°C	0.935
VAPOR PRESSURE (mm Hg)	Not Determined	PERCENT VOLATILE BY VOLUME (%)	Not Determined
VAPOR DENSITY (AIR=1)	Not Determined	EVAPORATION RATE (H ₂ O=1)	Not Determined
SOLUBILITY IN WATER	Insoluble		
APPEARANCE AND ODOR	Dark Colored Liquid		
	Mild Odor		

Section IV - REACTIVITY AND EXPOSURE DATA			
FLASH POINT (METHOD USED)	40°C (FHCC)	FLAMMABLE LIMITS	Not Determined
EXTINGUISHING MEDIA	CO ₂ , dry chemical, foam		
SPECIAL FIRE FIGHTING PROCEDURES	See above		
UNUSUAL FIRE AND EXPLOSION HAZARDS	COMBUSTIBLE: Avoid excessive heat, sparks or open flames.		

Section V: HEALTH HAZARD DATA	
1-PP5-OLD LIMIT VALUE	
No OSHA exposure standard or threshold limit value has been established for this product.	
EFFECTS OF OVEREXPOSURE	
Product is not expected to be toxic orally, nor is it expected to be a primary skin or primary eye irritant. Inhalation may cause respiratory irritation, dizziness, nausea and headache.	
EMERGENCY AND FIRST AID PROCEDURES	
For eye contact: Flush immediately with plenty of water for at least 15 minutes. For skin contact: Wash with soap and water. Inhalation: Remove to fresh air. Apply artificial respiration if breathing has stopped and call a physician.	

Section VI: REACTIVITY DATA		
STABILITY	UNSTABLE	CONDITIONS TO AVOID
	STABLE	Avoid temperatures above 37.8°C.
INCOMPATIBILITY (Identify what to avoid)		
Strong oxidizing agents.		
HAZARDOUS DECOMPOSITION PRODUCTS		
Thermal decomposition or burning may produce oxides of carbon, nitrogen and manganese.		
HAZARDOUS POLYMERIZATION	MAY OCCUR	CONDITIONS TO AVOID
	WILL NOT OCCUR	X

Section VII: SPILL/LEAK PROCEDURES	
STEPS TO BE TAKEN IN CASE MATERIAL IS RELEASED OR SPILLED	
Handle as an oil spill. Avoid breathing vapors or mists - use adequate ventilation.	
Prevent entry into sewers and waterways.	
WASTE DISPOSAL METHOD	
Chemical waste disposal is governed by the Resource Conservation and Recovery Act as well as both other local, state and federal laws and regulations.	

Section VIII: SPECIAL PROTECTION INFORMATION	
RESPIRATORY PROTECTION (Specify type)	
VENTILATION	LOCAL EXHAUST
	MECHANICAL (General)
	X
	X
SPECIAL	
OTHER	
PROTECTIVE CLOVES	
Plastic or rubber gloves recommended	
EYE PROTECTION	
Chemical Splash Goggles Recommended	
Other protective equipment	
Above protective devices are recommended to conform with recognized hygienic practices when handling chemicals.	

Section IX: SPECIAL PRECAUTIONS	
PRECAUTIONS TO BE TAKEN IN HANDLING AND STORING	
CAUTION! COMBUSTIBLE: Store at temperatures below 37.8°C. Store in a cool, dry area in tightly closed containers. Use adequate ventilation - avoid breathing vapors or mists.	
Other precautions	
Avoid excessive heat, sparks or open flames. Normal hygienic and safety precautions should be observed when handling chemicals. Avoid prolonged or repeated contact with the skin.	

5351
OFF

Charles Hay



November 26, 1985

NOV 30 1985

VOLKSWAGEN OF AMERICA, INC.
380 W. Big Beaver
P.O. Box 3001
Troy, Michigan 48067-3001
Tel. (313) 362-0000
VWU Telex - 230 620

Mr. Robert E. Maxwell, Director
Certification Division
Office of Mobile Sources
U.S. Environmental Protection Agency
2565 Plymouth Road
Ann Arbor, MI 48105

Subject: Manganese Fuel Additive-based Particulate Trap
Regeneration System.

Dear Mr. Maxwell,

We have received your August 16, 1985 letter and appreciate your response to the request of Volkswagen of America, Inc. (Volkswagen) to certify vehicles using a manganese fuel additive for diesel particulate trap regeneration. Volkswagen understands that EPA is approving the use of this system, on a limited basis, through the 1988 model year and will not allow certification of vehicles using this diesel particulate control system for 1990 and later model years unless significant progress is made in what EPA views as necessary research. Volkswagen's understanding of the scope of the remaining research believed necessary by EPA, is summarized in the two points stated below:

1. A study which assesses the potential harmful effects, at low ambient concentrations and exposure levels, of the additive, Lubrizol 8220, or of the exhaust emission products resulting from the combustion of the additive.
2. A study which addresses EPA's concerns regarding compliance with the requirements of Sections 202(a)(4) and 206(a)(3) of the Clean Air Act. Particular emphasis is to be given to the finding of "unreasonable risk" as it relates to the trade-off between diesel particulate control and control of other unregulated pollutants. The analysis should include an assessment of, in the case of manganese for example, the potential for an unreasonable risk to which the Volkswagen diesel particulate control system may contribute, taking into consideration the risk associated with ambient concentrations of manganese attributable to other sources.

Audi Volkswagen

EPA states that it expects Volkswagen to "... submit a detailed research plan to EPA ..." which "... should discuss all relevant health work in progress and give milestone dates when progress and final reports will be available." While a detailed research plan has not been prepared as yet, Volkswagen can provide some information which does address and in part satisfies, the research and statutory requirements stated above.

The information now available centers upon the Health Effects Institute (HEI) October 7, 1983 response to Volkswagen's request regarding the manganese-based fuel additive system. As EPA is aware, on June 29, 1984, Volkswagen requested that the HEI undertake an evaluation of the potential health issues related to the emissions from diesel-powered vehicles using the manganese fuel additive-based particulate trap regeneration system. HEI was presented with this task because, in Volkswagen's view as an HEI sponsor, the HEI was established to assume responsibility for independently conducting testing and evaluations which may be required of manufacturers under Section 202(a)(4) of the Clean Air Act. As quoted from the description of the HEI research program distributed by HEI on March 13, 1984;

"But judgments about mobile source regulation are also to be related to a quite different standard under another provision Title II of the Act where the Administrator is to assure that no "control device, system or element of design used in a new motor vehicle or motor vehicle engine ... will cause or contribute to an unreasonable risk to public health, welfare or safety". In making this judgement about whether the risk of any unregulated substance emitted by motor vehicles is unreasonable, the Administrator must take into consideration how the use or non-use of the proposed technology will effect emissions of other substances - regulated or unregulated - which affect health, welfare or safety. 202(a)(4).

Since the Institute was established "to become the major source of studies on the health effects of mobile source emissions in the country", the Health Research Committee, in consultation with its sponsors and other members of the public, develops its research program to contribute to the data base on which these regulatory decisions can be made."

In the October 7, 1985 HEI response, Mr. Thomas P. Grumbly, Executive Director of HEI, summarizes the HEI analysis of the known health effects of manganese in the context of the vehicle application described by Volkswagen. A copy of this letter is enclosed for use by EPA in further evaluation of the health related effects of manganese and combustion products of the manganese-based fuel additive. Following his introductory remarks, Mr. Grumbly begins the discussion with a section entitled, Framework and Process which includes a description of the relationship between the Volkswagen request and the statutory obligation which HEI's efforts would help satisfy, namely the requirements of Section 202(a)(4). Also included is reference to a letter from EPA officials in which HEI is recognized as "the primary mechanism through which participating motor vehicle manufacturers discharge their health testing responsibilities under Section 202(a)(4) of the Clean Air Act." In light of the work that has been accomplished by HEI considerable progress has been made toward meeting the statutory requirements and assessing the ambient concentrations of manganese contributed to by automotive sources and by other sources.

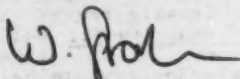
Volkswagen's review of the HEI document leads to the following conclusions. Volkswagen agrees that work must still be undertaken to satisfy the research required in Point 1 above, but according to our interpretation, Volkswagen specifically is only responsible for performing adequate measurements for chemical characterization of the exhaust emission components from vehicles equipped with the manganese-based additive system. As stated in the HEI analysis, a gap still exists in the information required to do a complete health effects assessment. The lacking information consists of data on the size distribution of particles emitted from the tailpipe and the amount and species of manganese they contain. Such information will be obtained by Volkswagen, and then submitted to HEI for inclusion in the health effects assessment. Although the characterization study is in process, no schedule for completion of the study has been compiled as yet.

With respect to Point 2, the HEI assessment, in Volkswagen's opinion has addressed the issue of "unreasonable risk" and therefore satisfies, to the extent possible for an automobile manufacturer, the requirements of Sections 202(a)(4) and 206(a)(3) of the Clean Air Act.

-4-

Following EPA's review of the HBI document, Volkswagen would be pleased to meet with EPA and discuss any questions that may arise if such discussion is desired, do not hesitate to contact our office.

Best Regards,



Wolfgang Groth

Attachment

cc: Mr. Stanley Blacker, U.S. EPA
Mr. Thomas Cackette, California Air Resources Board
Mr. C.D. Drachand, California Air Resources Board
Mr. Charles Gray, U.S. EPA
Mr. Thomas Grumbly, Health Effects Institute
Mr. Lawrence Slimak, Motor Vehicle Manufacturers Association

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
 APWC:Wagner:bb:x413:2565 Plymouth Rd:3/20/86:CD# 5397b

24 MAR 1986

Mr. Wolfgang Groth, Manager
 Volkswagen of America, Inc.
 888 W. Big Beaver
 P.O. Box 3951
 Troy, MI 48067-395

Dear Mr. Groth:

Subject: Manganese Fuel Additive-Based Particulate Trap
 Regeneration System

This letter clarifies those items which remain outstanding from our August 16, 1985 letter regarding your proposed usage of a manganese fuel additive for diesel trap regeneration.

Our August 16, 1985 letter granted approval only on a limited basis because no studies have yet been conducted that address the potential harmful effects of manganese at the low ambient concentrations that would likely result from this use. Our temporary approval to use this additive was based on the fact that one use of the system, in a small portion of the in-use fleet over the next few years, will have a negligible impact on current ambient manganese levels. The letter also stated, however, that until Volkswagen can provide EPA with conclusive data on the long term health risks at various projected ambient levels, EPA cannot grant permanent approval under current policy and statute.

Our concern in this matter involves Sections 202(a)(4) and 206(a)(3) of the Clean Air Act which, when taken together, make it clear that the manufacturer is responsible for presenting conclusive evidence showing that an emission control system will not cause or contribute to an unreasonable risk to public health, welfare, and safety.

Volkswagen met these requirements in part, through the paper completed by the Health Effects Institute (HEI). While the paper states that increased air concentrations of Mn resulting from the use of Volkswagen's particulate trap will not, under any realistic scenario, reach the lowest concentrations that have been reported in the literature to be associated with adverse chronic health effects, certain gaps remain in available information on manganese emissions and effects. HEI specifies that these gaps involve the particulate size distribution and chemical species (e.g., MnO_2 , Mn_3O_4) in which manganese is emitted and how they might affect toxicity. HEI states that these gaps have not been dealt with by the manufacturer directly as more experience is obtained.

SYMBOL	manufactured directly as more experience is obtained.				CD
SURNAME	AKD	B. J. J.	3/21/86		
DATE	3/21/86	3/21/86	3/21/86		3/24/86

EPA Form 1320-1 (2-79)

OFFICIAL FILE COPY

-2-

In ~~conclusion~~, the outstanding requirements indicated through the HEI ~~assessment~~, we requested that Volkswagen consider several trade-offs in the finding of unreasonable risk. These include consideration of trade-offs between diesel particulate control and control of other unregulated pollutants (e.g., manganese), a comparative analysis of alternative competing technologies, and a "comparison among unregulated pollutant risks" and then a "balancing" of these factors.

Finally, we stated that the certification of vehicles using manganese additives would not be authorized beyond the 1988 model year unless significant progress is made in conducting necessary research. To this end EPA requested that Volkswagen submit a detailed research plan to EPA by late in 1985 or early in 1986. This plan would include a discussion of relevant health work in progress and give milestone dates when progress and final reports would be available.

In your November 26, 1985 letter to me, you acknowledged the deficiencies pointed out in the HEI assessment and agreed to obtain the outstanding information and submit it to HEI for inclusion in the health effects assessment. You have also concluded, however, that the issue of "unreasonable risk" has been adequately addressed in the HEI assessment. We do not concur.

The HEI report did not conclude that there was no health effect at low levels of manganese exposure. HEI said that the available health information does not cover the range of interest. The HEI assessment provided no convincing rationale for why no adverse effects can be reasonably expected in the ambient range where data are lacking for manganese. In fact, additional health research may be needed versus an additional review of available information once more information is available on manganese emission products.

While you have agreed to obtain the information on particle composition and size distribution that HEI and EPA requested, no detailed time-schedule for completing this work has yet been submitted. We believe that this information should be obtained as quickly as possible so that it can be available to HEI and EPA. Additionally, a detailed research plan should be provided stating information on the testing to be done including how many vehicles would be tested, what types of driving cycles would be used, and what types of analyses would be done on the samples collected. We can reach a decision on the question of unreasonable risk only if the required information has been obtained and examined by EPA. Thus, it is to your advantage to obtain the necessary data and submit a research plan at the earliest possible date.

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
 PNC:Waguer:DB: 417-2565 Plymouth:1/20 86:CB4 197b

24 MAR 1986

-3-

In conclusion, we believe that the public health issue for the use of manganese remains an open issue for future years. In early 1985 we asked HEI to determine what type of research would be adequate to support a more definite answer to the risk question and to initiate such research. We have asked HEI to again address this original request. We urge you to make a similar request.

As stated in our August 16, 1985 letter, EPA will not authorize the certification of vehicles using manganese additives beyond the 1988 model year unless significant progress is made in conducting all necessary research. We would expect the entire issue should be resolved in time to decide on a control strategy for the 1990 and later model years.

Sincerely yours,

Robert E. Maxwell, Director
 Certification Division
 Office of Mobile Sources



UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

ANN ARBOR, MICHIGAN 48105

April 2, 1986

OFFICE OF
AIR, NOISE AND RADIATION

Dear Manufacturer:

CD-86-06 (LD)

Subject: Compliance with Sections 202(a)(4) and 206(a)(3) of
the Clean Air Act

On August 16, 1985, EPA sent the enclosed letter to Volkswagen of America, Inc. (Volkswagen) conditionally approving its request to use a manganese fuel additive for particulate trap regeneration for its light-duty diesel vehicles. This letter gave approval for Volkswagen to use this additive for the 1986-1988 model years. EPA's temporary approval of this additive's use was based on the fact that its use only by Volkswagen in its diesel vehicles (a small portion of the in-use fleet over the next few years) will have a negligible impact on current ambient manganese levels. This letter states, however, that until Volkswagen can provide EPA with conclusive data on the long term health risks at various projected ambient levels, EPA cannot grant permanent approval under current policy and statute. The enclosed letter to Volkswagen is provided as an example of how EPA will address any similar requests by manufacturers in the future.

Advisory Circular Nos. 76 and 76-1 (Subject: Compliance with the Requirements of Sections 202(a)(4) and 206(a)(3) of the Clean Air Act) provide background on EPA's policy in addressing Volkswagen's request or other similar requests involving currently unregulated pollutants. The language of Sections 202(a)(4) and 206(a)(3) taken together make it clear that it is the manufacturer's responsibility to provide sufficient evidence that an emission control system will not cause or contribute to an unreasonable risk to public health, welfare or safety.

On March 20, 1984, EPA sent a letter to all manufacturers concerning clarification of the role of the Health Effects Institute (HEI) with regard to Section 202(a)(4). This letter indicated that EPA will accept conclusive data from health effects projects sponsored by the HEI as satisfying the health testing requirements of this section. Also the letter indicated that manufacturers must submit needs requests to HEI;

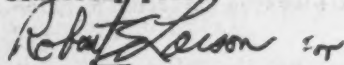
-2-

the needs should clearly specify the health effects research which the manufacturer deems most important. Additionally, these needs requests should be submitted sufficiently in advance so that needed health data can be obtained in time for both the manufacturer and EPA to assess any health problems prior to manufacturers' decisions on commercialization of a new technology. Use of HEI to provide conclusive health data to EPA is not required however. Manufacturers may, of course, submit health data independent of work done by HEI.

Finally, data which provides conclusive evidence of the health risks associated with an emission control system (either presented through HEI for the manufacturer or by the manufacturer independent of HEI) satisfies only part of the requirements of Sections 202(a)(4) and 206(a)(3). An example of the type of information needed (and is not satisfied by HEI work) is emission characterization tests to identify unregulated emissions from vehicles or engines being certified. Such characterization testing is part of the manufacturers' statutory responsibility to assure that emission control devices, systems, or elements of design in new motor vehicles or engines do not cause or contribute to an unreasonable risk to public health, welfare, or safety. Thus, besides its responsibilities relative to health risk assessment of the use of a manganese fuel additive, Volkswagen, for example, must submit detailed information which characterizes the resulting exhaust emissions. Specifically, Volkswagen must identify the chemical forms and respective quantities of each form of manganese emitted. Detailed research plans and time schedules to be followed in acquiring this information must also be submitted to EPA by Volkswagen.

I hope you find this information useful. Please advise if you have any questions.

Sincerely yours,



Robert E. Maxwell, Director
Certification Division
Office of Mobile Sources

Enclosure



UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
ANN ARBOR, MICHIGAN 48105

OFFICE OF
AIR AND RADIATION

AUG 11 1986

MEMORANDUM

SUBJECT: HEI's Role in Assessing the Health Effects of
Unregulated Pollutants: (1) EPA's Request for an
Evaluation of Manganese and (2) the Meaning of
"Conclusive Data" in Maxwell letter of March 24, 1986

FROM: Charles L. Gray, Jr. *CLG*
Director
Emission Control Technology Division
United States Environmental Protection Agency

Thomas P. Grumbly *Thomas P. Grumbly*
Executive Director
Health Effects Institute

Robert Maxwell *Robert Maxwell*
Director
Certification Division
United States Environmental Protection Agency

TO: The Record

This memorandum summarizes, and provides background information, concerning a telephone discussion on June 5, 1986 among the following participants.

Thomas P. Grumbly, Executive Director
Health Effects Institute

Dr. Ken Sexton, Director
Scientific Review and Evaluation
Health Effects Institute

Dr. Robert Kavet, Senior Staff Scientist
Health Effects Institute

-2-

Mr. Charles Gray, Director
Emission Control Technology Division
Office of Mobile Sources
Environmental Protection Agency

Mr. Phil Lorang, Chief,
Technical Support Staff
Emission Control Technology Division
Office of Mobile Sources
Environmental Protection Agency

Mr. Robert Maxwell, Director
Certification Division, Office of Mobile Sources
Environmental Protection Agency

Dr. Joseph Somers,
Office of Mobile Sources
Environmental Protection Agency

Ms. Penny Carey
Office of Mobile Sources
Environmental Protection Agency

Mr. Matthew Wagner
Office of Mobile Sources
Environmental Protection Agency

The discussion dealt with HEI's response to Volkswagen's request of June 1984 on manganese, the general role of HEI in the unregulated pollutant evaluation process, and the meaning of "conclusive data" as expressed in Mr. Robert Maxwell's letter of March 24, 1986 to Volkswagen and more general guidance provided to manufacturers by Mr. Maxwell in a letter of April 2, 1986. The telephone call was initiated in response to a prior request by Mr. Grumbly to Mr. Richard Wilson, Director of the Office of Mobile Sources.

I. Introduction: The Statutory Framework

Section 202 (a)(4) of the Clean Air Act, 42 U.S.C. 7521 (a)(4) 1983 states:

(4) (A) Effective with respect to vehicles and engines manufactured after model year 1978, no emission control device, system, or element of design shall be used in a new motor vehicle or a new motor vehicle engine for purposes of complying with standards prescribed under this subsection if such device, system, or element of design would cause or contribute to an unreasonable risk to public health, welfare, or safety in the operation or function.

(B) In determining whether an unreasonable risk exists under subparagraph A the Administrator (of EPA) should consider among other factors:

(i) whether and to what extent the use of any device, system or element of design causes, increases, reduces or eliminates emissions of any unregulated pollutant;

(ii) available methods for reducing or eliminating any risk to public health, welfare or safety which may be associated with the use of such device, system or element of design and;

(iii) the availability of other devices, systems or elements of design which may be used to conform to the standards prescribed under this subsection without causing or contributing to such an unreasonable risk. The Administrator shall include in the consideration required by this paragraph all relevant information developed pursuant to Section 7458 of this title. [Section 7458 which codifies Section 214 requires that the Administrator conduct a study and analysis of particulate emissions of motor vehicles covered by 202(a)(4), which characterizes and quantifies such emissions and analyzes the relationship of such emissions to fuels and fuel additives used.]

A companion statute, Section 206(a)(3), 42 USC 7525 (A)(3)(1983) states:

"3(A) a certificate of conformity may be issued under this section only if the Administrator determines the manufacturer. . . . has established to the satisfaction of the Administrator that any emission control device, system, or element of design installed on, or incorporated in, such vehicle or engine, conforms to the applicable requirements of Section 7521 (a) (4) of this title.

(B) the Administrator may conduct such tests and may require the manufacturer. . . to conduct such tests and provide such information as is necessary to carry out subparagraph A of this paragraph."

Section 206 (b), 42 USC 7525 (b) (1983), which governs the testing procedures and judicial review of certification decisions by the Administrator under this statute, provides that the Administrator is authorized to direct manufacturers to conduct tests to determine whether vehicles do conform to the regulations, and that manufacturers may file a petition with the appropriate United States Court of Appeals for judicial review of such determination. The court shall review this order in accordance with the "substantial evidence" standard of the Administrative Procedure Act. See 5 USC 706 (1977)

II. The Role of the Health Effects Institute

The Health Effects Institute was created in part to provide a mechanism for satisfying the statutory health testing obligations under section 202(a)(4). The Health Effects Institute functions to organize, fund, conduct, and evaluate research on the health effects of motor vehicle emissions. The EPA has stated that it would fully expect the Institute to become the primary mechanism by which participating motor vehicle manufacturers discharge their health testing responsibilities under 202 (a)(4) in a memorandum to the Motor Vehicle Manufacturers from Joseph A. Cannon, Assistant Administrator for Air and Radiation, and Bernard Goldstein, Assistant Administrator for Research and Development, EPA, March 20, 1984 (hereinafter the Cannon/Goldstein memorandum, Attached as Appendix A). In the Cannon/Goldstein memorandum, EPA further stated: "the EPA position on the Institute . . . will remain unchanged providing each manufacturer continues to identify in an annual written needs submission to (HEI) that health effects research which the manufacturer deems most important."

III. The HEI Manganese Report and the Maxwell Letter

Relying on the EPA's statement in the Cannon/Goldstein memorandum, Volkswagen of America, Inc. (VW) requested in June 1984 that HEI undertake an evaluation of potential health issues related to emissions from diesel automobiles using manganese-containing fuel additives for particle trap regeneration. By permitting regeneration to occur at exhaust temperatures which are reached naturally in normal operation, the manganese additive avoids the need for more expensive or otherwise less attractive regeneration approaches. Therefore within the context of the VW system, the manganese additive in question is essential to the control function of the trap and lowers emissions to levels that comply with Federal and California state environmental statutes. Any such emissions control device must meet the requirements of section 202(a)(4), that is, it must not pose an "unreasonable risk" in operation.

To fulfill its role in helping to implement 202(a)(4), HEI conducted an evaluation of manganese through its Health Research Committee. In September 1984, the Committee met, discussed the VW request and received a preliminary briefing on the toxicology of manganese. The Committee agreed to accept the request by VW and it decided that further analysis was necessary to determine whether tail pipe emissions of manganese are a public health problem, and whether HEI should sponsor research in this area. HEI subsequently commissioned Roth Associates (Dr. Neil Roth, Principal Investigator) to conduct an in-depth review of the relevant literature and studies on manganese. This review included actual replication of VW

modeling predictions of potential manganese exposure levels from use of the manganese additive and additional modeling of other emissions scenarios not analyzed by VW, plus analysis of the health effects literature. The Committee evaluated all of this information in June 1985, and conducted a final review in September 1985.

In a letter report to VW dated October 7, 1985 (hereinafter "HEI Report", HEI summarized its evaluation:

"The evaluation first places projected Mn emissions in the context of ambient Mn levels across the United States, and then examines the health literature on Mn to establish whether the expected incremental levels of airborne Mn from regenerator-equipped automobiles are of health-related concern. Finally, we identify a number of areas in which our knowledge concerning exposure and potential effects can be improved."

"To summarize our findings, increased air concentrations of Mn resulting from the use of VW's particle trap will not, under any realistic scenario, reach the lowest concentrations that have been reported in the literature to be associated with adverse chronic health effects. Despite this conclusion, certain gaps remain in our knowledge of Mn emissions and effects. These gaps primarily involve the particle size distribution and chemical species . . . in which Mn is emitted and how they might affect toxicity. The gaps in emissions characterization are best dealt with by the manufacturers directly as more experience is obtained." (HEI report, pages 2-3)

VW submitted the HEI report to the EPA in compliance with its obligations under section 202(a)(4). In response, in a letter dated March 24, 1986 (hereinafter the "Maxwell letter" in Appendix B), Robert Maxwell, Director of the Certification Division, Office of Mobile Sources, EPA, stated to VW that although VW's submission of the HEI report had "in part" met the requirements of section 202(a)(4), VW had not completed adequately the necessary submission to address the issue of unreasonable risk. The Maxwell letter asked VW to submit a detailed time schedule for providing the information on particle composition and size distribution that the HEI report noted (at p.8) was needed to "reinforce the conclusion that no health effects are expected" at the low ambient levels likely to result from its proposed use.

During the June 5, 1986 conference call, EPA staff members raised several questions about possible ambiguities in HEI's letter to Volkswagen. Taken together, these ambiguities raised doubts among EPA staff about the health effects research base for manganese. Mr. Grumbly indicated that the HEI staff had

already performed further analyses of the one Japanese study that seemed to have been conducted at exposures that approximated those thought to be of potential health concern. They had concluded that this study was quite unreliable and was probably not even a measure of manganese.

Mr. Grumbly and the HEI staff agreed with an EPA request to submit another letter on this issue and to be as unambiguous as possible in assessing the health effects data base. As part of this effort, the HEI Research Committee had asked the staff to develop an updated paper based upon the new information. Mr. Grumbly also stressed that Volkswagen still had responsibility for characterizing emissions, and that any new emissions characterization data would be carefully analyzed so that EPA had the most complete information base possible.

With respect to HEI's general role in the review of new technologies requiring certification under section 202(a)(4), EPA reiterated that it was looking to HEI to play the primary health effects research role, and to provide the Agency with HEI's views about the adequacy of the existing data base concerning new technology. HEI and EPA understand and agree that only the Agency and the manufacturers can perform the actual certification required by the standard of 202(a)(4). HEI and EPA also agreed that HEI should provide the most complete evaluation of existing evidence reasonably possible, and should provide the manufacturer with the clearest possible interpretation of that evidence, consistent with the underlying uncertainties in the scientific data base. HEI will not normally engage in quantitative risk assessment, but it will evaluate and array the available data so that EPA and the manufacturer(s) can undertake such an assessment, if the data are sufficient to warrant the effort.

IV. The Problem of "Conclusive Evidence" or "Conclusive Data"

Although it appears from the Maxwell letter that EPA will be satisfied if Volkswagen produces the information on particle composition and size distribution requested specifically, the text of the Maxwell letter went further, and HEI was concerned that its tenor could potentially create problems for HEI's role as spelled out in the Cannon/Goldstein memorandum. The letter states that section 202(a)(4) requires the manufacturer to present "conclusive evidence" or "conclusive data" that an emission control system will not cause or in any way contribute to an unreasonable risk. Both HEI and EPA agreed that "conclusive evidence" or "conclusive data" requires further explanation.

V. Summary of Positions

EPA and HEI staff agree that the following restatements accurately describe each group's position and that they are essentially compatible with each other and with all prior correspondence including the Maxwell letters of March 24 and April 2.

EPA

1. EPA will continue to accept manufacturer statements during Certification regarding the absence of unreasonable risk, for "current" technologies with a history of characterization.
2. EPA expects manufacturers to continue to report annually on their developing technologies and the emissions characteristics thereof. Manufacturers are also expected to request from HEI assessment of the current state of knowledge with respect to a particular pollutant, or new testing of the health effects of the pollutant, for pollutants which may be newly emitted or emitted in larger amounts from a technology with commercial potential. By doing so, they will increase the information available at the time they might seek certification of the technology, and thereby decrease the likelihood that EPA will be unable to decide in favor of certification due to lack of sufficient information.
3. Manufacturer fulfillment of these two expectations does not by itself guarantee that EPA will grant a certificate for a new technology when one is requested. EPA must be able to make a finding or conclusion that there will be no unreasonable risk to public health from the technology. If, despite the manufacturer's annual reports to EPA and requests to HEI, EPA is lacking information to make a finding or conclusion without being arbitrary or capricious, a certificate will not be granted. In the sense of permitting EPA to reach a non-arbitrary/capricious conclusion, the evidence on health effects must be "conclusive".
4. As in the case of Volkswagen's request, EPA may agree to grant a certificate for a small number of model years if the cumulative production will be so small that a finding of no unreasonable risk is possible, to allow for more information to be provided. Manufacturers should not rely upon this possibility, however.

5. In the case of manganese emissions from trap-equipped light-duty vehicles, the October 7, 1985 HEI response to Volkswagen was inadequate for EPA to reach a long-term decision in favor of certification. As noted by HEI, VW had not performed characterization testing to rule out the possibility that the manganese is emitted in an unusual form, i.e., other than as an oxide or elementally. Also, although HEI concluded that there was an absence of studies showing a health effect at expected levels, it provided no affirmative evidence or reasoning as to why an effect was unlikely nor even any clearly stated conclusion or scientific opinion that effects were unlikely. When clear health effects have been demonstrated at higher levels and been accepted by the scientific community, EPA believes that the mere existence of a sizeable difference in concentrations is not enough. Credible inference regarding the lower levels must be based on some additional evidence, such as:
- a scientifically valid and relevant intermediate-level study with no effect
 - comparison to dietary intake, or to current inhalation exposures from other sources
 - studies on similar compounds
 - knowledge of metabolic pathway or clearance mechanisms.
6. Expert opinion provided through the HEI Committee structure in the absence of definitive data will be highly respected by EPA. EPA expects that such opinions will be clearly stated, with a clear explanation of any computations, assumptions, or judgments used to evaluate the substance in question. Also, the degree of uncertainty should be described, as well as the research program which would better resolve any uncertainty. Of course, EPA and not HEI must make the findings required by the statute.
7. The degree of uncertainty which can be tolerated in making a finding regarding the presence or absence of unreasonable risk depends in part on the cost and time required to remove that uncertainty through additional research.

HEI

1. Inference is often a vital part of the evaluation of the health effects of a substance at a given exposure level. The term "conclusive evidence" is therefore a misnomer.
2. Science cannot provide "conclusive" proof for an absence of health effects. Reliable data on relevant compounds, levels, exposure routes, exposure times, and species accompanied by credible expert inference as to the presence or absence of human health effects under expected exposure conditions can be provided. HEI sees this as part of its role under Section 202(a)(4), since HEI must necessarily consider the available data and form these same inferences when deciding whether and what type of new testing to perform.
3. In addition to being unable to provide "conclusive" proof, science generally does not even yield "conclusive" data. The observations that count as support are themselves dependent on theoretical structures that are subject to change. Furthermore, the sciences that search for adverse health effects (e.g., toxicology and epidemiology) do not yield "conclusive" data that will with total certainty predict that an effect will not occur. With respect to any experiment or study, the risk of a false negative or a false positive is never zero. Nor are there sufficient resources to test for every theoretical possible toxic effect at every possible exposure level under all conceivable sets of experimental conditions. Even if it were possible to achieve all this in animals, extrapolation to humans would still be fraught with some uncertainty.
4. HEI has the responsibility, in evaluating evidence and in deciding whether to undertake research, to provide a clear explanation of any computations, assumptions or judgments used to evaluate the particular substance or technology in question, under the intended conditions of use. HEI will clearly distinguish in any analysis between those research recommendations which could refine specific uncertainties about human risk, and those which are important to pursue in order to reach a scientifically defensible judgment about the fundamental nature and extent of human risk.



THE MOUNT SINAI MEDICAL CENTER

ONE GUSTAVE L. LEVY PLACE • NEW YORK, N.Y. 10029



Mount Sinai School of Medicine • The Mount Sinai Hospital

Philip J. Landrigan, M.D., M.Sc.
 Director, Division of Environmental
 and Occupational Medicine
 Department of Community Medicine

(212) 650-6173

January 2, 1987

E. E. McConnell, D.V.M.
 Director, National Toxicology Program
 National Institute of Environmental Health Sciences
 Research Triangle Park, NC 27711

Dear Gene:

I would like formally to nominate organic manganese compounds, in particular methylcyclopentadienyl manganese tricarbonyl (MMT), for evaluation by the National Toxicology Program. This compound is scheduled for increasing use as a motor fuel additive. Therefore, opportunities will likely arise for both occupational and community exposure. Neurotoxicologic evaluation will be especially important.

Inorganic manganese is a known neurotoxin. It penetrates the basal ganglia and produces a Parkinson-like syndrome.

Previous experience with organometallic compounds, such as tetraethyl lead and methyl mercury, indicates that these moieties penetrate the central nervous system more efficiently than their inorganic congeners. There is every reason to believe that the same phenomenon will pertain in the case of manganese. Concern arises, therefore, that the organic manganese compounds will be quite neurotoxic.

The toxicology literature on MMT is sparse. There is very little information on its neurotoxicity. Such information is urgently needed before this material finds wide use in the automotive industry.

I was informed in late 1986 that Volkswagen Corporation of America plans to place small tanks containing liquid organic manganese compound in certain new car models. I was informed further that they had already received approval for this practice from the U.S. Environmental Protection Agency. Although the argument is put forth by Volkswagen that little human exposure will occur under normal conditions, I am not aware that anyone has considered the possibility of human exposure in the event of automobile wreck, fire, tank leak, or other unscheduled event. The consequences of such exposure could be very serious and could involve neurotoxicity.

E. E. McConnell, D.V.M.

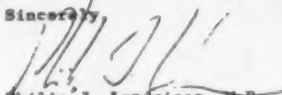
- 2 -

January 2, 1987

Given that these organic manganese compounds will find use in the near future, I request that you place these compounds on test, as soon as possible.

All best regards,

Sincerely,



Philip J. Lendrigan, M.D.
Professor

PJL:ss

bcc: Ellen K. Silbergeld, Ph.D.



DEPARTMENT OF HEALTH & HUMAN SERVICES

Public Health Service

January 14, 1987

National Institutes of Health
National Institute of
Environmental Health Sciences
P O Box 12233
Research Triangle Park, N C 27709

Dr. Philip J. Landrigan
Professor
Mount Sinai Medical Center
One Gust Avenue L. Levy Place
New York, NY 10029

Dear Phil:

This is in reference to your letter of January 2, 1987, nominating methylcyclopentadienyl manganese tricarbonyl (MMT) for study by the National Toxicology Program. I have forwarded it to Dr. Dorothy Canter who manages our chemical nomination and review process. Dr. Bruce Fowler recently made me aware of MMT and the potential toxicity thereof. I understand the two of you discussed it and I appreciate your concern. This represents a real opportunity to get ahead of the game.

I appreciate your continued interest in the NTP.

Sincerely yours,

Ernest E. McConnell, D.V.M.
Director, Toxicology Research
and Testing Program

cc:
Dr. D. Canter
Dr. D. Rall



UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
ANN ARBOR, MICHIGAN 48105

OFFICE OF
AIR AND RADIATION

MAR 11 1987

Dr. Victor A. Fung
Chemical Selection Coordinator
Public Health Service
National Institutes of Health
Bethesda, Maryland 20205

Dear Dr. Fung:

In your recent letter and phone conversation with me, you asked for some information on manganese additives.

MMT (methylcyclopentadienyl manganese tricarbonyl) is a gasoline additive that boosts octane. EPA has denied several waiver requests to use MMT in unleaded gasoline due to exhaust hydrocarbon increases associated with MMT. Even though MMT is not used in unleaded gasoline, it can be used in leaded gasoline although it is not economical compared to lead. Besides, the use of leaded gasoline is decreasing significantly due to EPA regulations on lead and the decreasing number of older vehicles that can use leaded gasoline. However, use of MMT is permitted in Canada.

An organomanganese additive can be used in diesel vehicles equipped with particulate traps for trap regeneration. EPA has given VW permission to use such an additive (the formula is proprietary but it is not MMT) in the 1987 and 1988 model years. VW has not used this additive in 1987. EPA has specifically told VW that it will not be able to use this additive beyond the 1988 model year unless significant progress is being made towards obtaining more health data associated with this additive. No other manufacturer has requested permission to use such an additive in its trap-equipped diesels at this time. Presently, those light duty diesel models equipped with particulate traps use a thermal type regeneration which does not require use of manganese to lower the regeneration temperature.

EPA recently evaluated in great detail the health effects that could be associated with manganese as an air pollutant as discussed in the enclosed Federal Register notice. The EPA Office of Mobile Sources evaluated the health effects that may be associated with use of this manganese additive in the VW

-2-

system and concluded that there would be no adverse effects with the low levels associated with VW's use of this additive for several model years. Enclosed is a letter summarizing EPA's decision on manganese. Also, the Health Effects Institute (as we discussed) has evaluated the health effects associated with use of the manganese additive by VW and made a similar conclusion; the Health Effects Institute is presently looking at this question in more detail and should issue another report later this year.

I hope this information is helpful to you and shows you how seriously EPA considered the VW request before giving it approval for two model years.

Sincerely yours,

Joseph H. Somers

Joseph H. Somers
Project Manager
Technical Support Staff

Enclosures



DEPARTMENT OF HEALTH & HUMAN SERVICES

Public Health Service

National Toxicology Program
Bethesda, MD 20892

April 17, 1987

Dr. Philip J. Landrigan
 Director, Division of Environmental and
 Occupational Medicine
 Mount Sinai Medical Center
 One Gustave L. Levy Place
 New York, NY 10029

Dear *(2nd)* Dr. Landrigan:

As we discussed, Dr. E. McConnell has referred your nomination of organic manganese compounds, in particular methylcyclopentadienyl manganese tricarbonyl (MMT), for toxicological evaluation by the NTP to me as head of the NTP chemical nomination and selection process.

MMT was previously nominated to the NTP by the EPA in July 1984 for reproductive toxicity studies based on the moderate production volume of the chemical, and the high skin absorption and toxic effects observed in humans. The NTP Chemical Evaluation Committee (CEC) and Board of Scientific Counselors (BSC) reviewed the chemical in April 1986 and November 1986, respectively. Both the CEC and BSC recommended no testing for MMT based on the low potential for exposure. It was noted that MMT has not been approved for use as an additive in unleaded gasoline in the U.S. since September 1978. However, the BSC recommended that MMT be reconsidered if new uses were developed for it.

After receiving your letter to Dr. McConnell, we contacted the EPA to request information about their program on the manganese compounds and their interaction with the Volkswagen Corporation of America. EPA staff informed us that they had denied several waiver requests to use MMT in unleaded gasoline because increases of exhaust hydrocarbons were associated with its use. EPA did give approval to Volkswagen to use an organomanganese additive (Lubrizol 8220) in diesel vehicles equipped with particulate traps for regeneration. The formula of this additive is proprietary information, but EPA has stated that it is not MMT. The approval was given to Volkswagen for use only in the 1986 through 1988 model years. Volkswagen may not use the additive beyond the 1988 model year without first providing additional data, including health effects data. EPA further informed NTP staff that Volkswagen decided not to use the additive in 1987.

Enclosed is the letter of March 11, 1987, from Dr. Joseph Somers, EPA, to Dr. Victor Fung concerning manganese additives, with relevant enclosures. We are also enclosing a copy of the draft NTP Executive Summary on MMT, prepared in 1986.

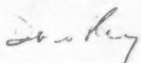
Page 2

Would you please review the enclosed materials and let us know whether you still wish the NTP to continue processing your nomination of MMT for toxicological studies. If there are other manganese compounds that you would also like to nominate, would you kindly identify them since the two review committees that evaluate nominations request that the compounds or mixtures nominated for testing be specified. Also it is our understanding that you are nominating MMT for acute and chronic neurotoxicological studies. Do you wish to nominate MMT or other manganese compounds for carcinogenicity studies as well?

At present, the NTP is performing feeding carcinogenicity studies on the inorganic manganese compound, manganese sulfate. The subchronic studies have been completed, and the two year studies are in progress. No other NTP testing of manganese compounds is currently planned.

Please let me know if I can be of further assistance regarding organic manganese compounds or if you need more information on the NTP chemical nomination and selection process.

Sincerely,



Dorothy A. Canter, Ph.D.
Assistant to the Director

Enclosures

cc: Dr. E. McConnell
Dr. D. Rall

SUMMARY OF
CONFERENCE ON
ENVIRONMENTAL HEALTH
IN THE 21ST CENTURY

Y

NATIONAL INSTITUTE OF
ENVIRONMENTAL HEALTH SCIENCES

The mission of the National Institute of Environmental Health Sciences (NIEHS) is to study the effects of environmental agents on human health. NIEHS research serves to alert physicians, the general public, legislators and regulatory agencies to the existence of hazardous environmental agents so that they may assess the risks of exposures and make sound judgments about how to protect public health and safety. NIEHS, one of the agencies of the National Institutes of Health, has the principal responsibility within the Federal Government for the support of research and the training of research personnel concerned with the effects of chemical, physical, and biological factors on human health.

SUMMARYCONFERENCE ON ENVIRONMENTAL HEALTH IN THE 21st CENTURY
NATIONAL INSTITUTE OF ENVIRONMENTAL HEALTH SCIENCES

INTRODUCTION

How safe and nutritious will our food be in the next century? Will we have enough clean water? What toxic exposures might we face inside our homes? Will the electromagnetic fields created by electronic devices in our offices and homes be dangerous to our health? These and other issues were addressed at a Conference on Environmental Health in the 21st Century held on April 5-6, 1988, by the National Institute of Environmental Health Sciences (NIEHS) in Research Triangle Park, North Carolina. Thirty speakers participated over the course of the day-and-a-half conference. Over 160 persons attended.

The purpose of the conference was to bring together experts in a wide range of fields to consider the environmental health implications of the technological, demographic, and other developments of the next century. The conference considered a number of future concerns, including food, water, shelter and indoor air, occupational health, and the detection of subtle hazards.*

*Due to time constraints, several issues which have been the focus of discussion elsewhere were not covered at this conference, including ozone depletion, outdoor air quality, global warming, recombinant DNA biotechnology, etc. It should also be noted that this conference was limited to environmental health issues in the United States and other economically developed countries.

There undoubtedly are exciting technological advances in the future which may enhance the quality of life and improve medical diagnosis and health care in dramatic ways. But desirable developments and changes can be accompanied by less than desirable side effects with negative consequences for environmental health. Thinking about the future and anticipating these side effects may make it possible to prevent or mitigate their negative health effects.

This attempt to look forward necessarily involved making predictions, an uncertain enterprise. Several historical examples cited at the conference reminded the listeners of this uncertainty, including predictions by astronomer Simon Newcomb in early 1903 that man would never be able to build a practical flying machine and by physicist Robert Milikan in 1923 that man would never be able to tap the power of the atom.

The lack of perfect foresight, however, must not discourage reasonable anticipation of future developments and problems, nor deter efforts to prevent or to resolve those problems before they are injurious to health.

PUBLIC ATTITUDES

The conference included a panel on the public's attitudes toward environmental health issues in the future. Public surveys indicate generally favorable attitudes toward environmental health efforts. There is strong support for increased action and regulation particularly when individuals perceive an environmental threat to their own health. Perceptions of environmental health risks seemed to be formed by both long-term impressions of hazards and protection measures, and by sudden

events such as the explosions at Bhopal and Chernobyl. Public awareness of events and actions affecting environmental health risks may be greater in the future as a result of increased availability of information through cable TV news and home information systems.

DETECTING SUBTLE EFFECTS

The first noted health effects of most toxic exposures are the obvious acute effects. Subtle effects usually are noted only later, if at all, because of difficulty in detecting the presence of the effects or because of difficulty in determining a relationship between the effects and an exposure.

Detecting an effect's presence can be difficult for several reasons. Some effects simply are beyond the capacity of current tests to detect. Other effects have health or behavioral consequences which are common enough to mistakenly be considered within the range of normal. Some neurobehavioral effects, especially in children, may be compensated for and thus obscured by other factors, such as special attention from parents or teachers.

In some cases the subtlety of an effect lies not in its health consequences, which may be devastating, but in determining its relationship to a toxic exposure. The difficulty in ascertaining that a health characteristic is the effect of an exposure may arise from the presence of covariates or from an extended time delay between the exposure and detection of the effect. Or sometimes the effects of an exposure may be so similar to the effects of other causes that the other causes are assumed to be responsible.

At the conference, research on lead and its effects was presented as a paradigm for future research on the detection of subtle effects from other environmental exposures. The acute effects of lead, especially from occupational exposure, have been recognized for a very long time, dating back at least to the Roman Empire. Only comparatively recently have the more subtle effects resulting from lower level, long-term exposures to lead been noted. These effects are now known to include cognitive and neurological deficits, congenital malformations, immunotoxicity, other deficits in growth and development, and hypertension. As a result of continuing research, the "no observable effects level" (NOEL) of lead in blood has dropped from approximately 60 ug/dl in 1977 to as low as 10-15 ug/dl in the most recent studies. These latest studies have focused on children and found significant neurobehavioral effects at lead levels even below those previously considered harmless.

Future actions to reduce the harmful effects of lead must include a decrease in exposure, determination of a threshold level if such exists, research into reversibility, and study of the effects of lifetime exposure on the aging process. Exposure has been reduced greatly in the last few years by regulation of auto emissions and paint, but lead which originated from those two sources is still present in dirt and dust, and concern is rising about lead leaching into drinking water from water pipes within homes.

The recent findings about the harmful effects of lead at lower exposure levels point out the necessity of continuing research into known toxins even after actions to decrease exposure are initiated. There will

undoubtedly be other cases where, as with lead, actions to reduce exposure below levels which cause obvious harmful effects are later found to be insufficient to protect against subtle effects.

The research on the effects of lead exposure also highlights the linkage between cellular, clinical, and epidemiological data. The research has revealed that lead causes changes in mitochondrial function at very low levels of exposure. Knowledge of such changes at the cellular level can be incorporated into future research, including epidemiological studies, on lead as well as other substances, to clarify the relationship between cellular and other, more obvious effects.

A closing comment in the conference's session on subtle effects pointed out that new toxic compounds, possibly including some of the compounds being considered for superconductors, are being released regularly into the environment. Even as medical science becomes more alert to subtle effects, some of these new compounds may cause acute effects as well. The need for testing and surveillance of new potentially toxic compounds was emphasized.

FOOD

New technology may make it possible to provide a diet with apparent variety of taste and texture which is actually produced from very few real food sources. While the virtually calorie-free cheeseburger and shake may seem desirable, a diet based on a few synthetic or biotechnologically-altered foods may be seriously deficient in necessary nutrients, some of which we do not yet understand or even know to exist. As long as we lack full information, safety lies in a varied diet.

Eating habits in the future will be heavily influenced by continued desires for convenience. In the United States, consumption of prepared foods and eating at restaurants are likely to increase as a result of such factors as dual income households and declining household size. Other influences will include desires for health food and ethnic foods as well as special dietary needs, especially for a large aging population.

Total food production is now estimated to be 10-20% more than needed to feed the world's population. But if world population doubles by the year 2020, total food production will be insufficient unless new technologies can greatly increase world food output. New systems to maximize production may include better integration of information on soil types, fertilizers, pesticides, and markets, use of chemical and biological means for producing and protecting plants, use of natural predators, and biodegradable and timed-release pest control.

Food processing in the 21st century will be more automated and will involve more utilization of biotechnology, fermentation, and enzymes. Processing will be concentrated in larger plants, broadening potential consumer exposure if accidental contamination occurs during processing.

There will be more use of irradiation to sterilize and preserve food, and more marketing of refrigerated food. Shelf life of fresh produce could be lengthened in the future as a result of the recent isolation of the gene which controls the ripening of fruits and vegetables.

Research into the effects of food on health may shed new light on the relationship between food and degenerative diseases such as arthritis, osteoporosis, dementia, immunodeficiency disorders, atherosclerosis, stroke, cancer, and some psychological conditions. Research may also pinpoint currently unknown food components, nutritive and non-nutritive, which are important to health maintenance, further reemphasizing the value of the varied diet.

WATER

Overall, water problems in the future are expected to focus more on the quality, not the quantity, of available water. Water quality suffers from both chemical and microbial contamination, from such sources as inadequately treated (or untreated) sewage disposal, industrial run-off, leaking waste storage or disposal facilities, agricultural chemicals, stormdrains, and others. The two major needs if we are to ensure good water quality in the future are the institution of routine multisource monitoring and the development of new treatment methods.

Because of the current lack of a national monitoring system, ground water quality is often unknown and the overall effectiveness of clean-up efforts cannot be evaluated. New treatment techniques should be developed and evaluation of their effectiveness will be necessary. Chlorination has been a valuable tool for water disinfection, but research is needed on various other possibilities.

Only about 2% of the rainfall in the United States as a whole is utilized. However, the uneven distribution of the rainfall, in time and geography,

has created severe supply problems in some localized areas, particularly in the western United States. Nine states, eight of which are west of the Mississippi River, account for 75% of the groundwater mining in the United States. But since ninety percent of water consumption in the West is for agricultural irrigation, only modest increases in the efficiency of water use in agriculture are needed to free up ample supplies for other uses. Such improvements will almost certainly occur, perhaps even before the 21st century.

Research is currently being conducted on fish in Boston Harbor and other harbors with raw sewage outfalls, which will provide significant information about both the quality of the waters where the fish are caught and about the safety of the fish for human consumption. The need for increased monitoring is an issue here, too--specifically, monitoring of aquatic food and determination of where contaminated fish are being caught, rather than only where they are being sold or served. If boundaries of contaminated aquatic areas could be mapped, fishing could be restricted to other waters while clean-up efforts are undertaken. Future research on fish will investigate the issue of contaminated food fish as conveyors to human consumers of the carcinogens and other noxious chemicals which humans have dumped into the waters.

INDOOR AIR

It has been estimated that 70-80% of our time is spent indoors and that concentrations of some contaminants typically are substantially higher indoors than outdoors. The risks of indoor exposures including radon, passive smoke, household chemicals, fine fibers and off-gassing from

carpets and appliances may be intensified in the future if houses get tighter as a result of energy cost increases. Future buildings are likely to be bigger and more complex, allowing occupants little if any control of their individual environments. In addition, the current building stock, which is expected to last well into the next century, includes many buildings with lead paint and asbestos, and many so-called "sick buildings," with colonization by micro-organisms of air supply ductwork or other inaccessible parts. Complaints of eye, nose, and throat irritation, fatigue, odors, headaches, and dizziness in such buildings typically are double the rate in non-"sick" buildings.

The general public is only now beginning to become aware of the danger of exposure to radon daughters. Radon arises from uranium, which is ubiquitous in the earth's crust, so exposure is widely distributed. Radon appears to interact multiplicatively with cigarette smoking in increasing the risk of lung cancer. Determination of the effects of residential exposure to radon are hampered by confounding factors such as tobacco use. But studies of underground miners and of lab animals show radon to be a potentially life-threatening public health hazard, especially among smokers.

Inclusion in future buildings of sensors to smoke, NO_2 , CO_2 , radon, and other pollutants would serve both to protect occupants of particular shelters and to raise public consciousness about the need for research and protection against indoor air hazards. The quality of residential indoor air will become even more important in the future if many people use their homes as workplaces, which is likely given computerized workstations and the demands of dual-income families for job flexibility.

The health risks from exposure to most man-made mineral fibers (MMMF) are uncertain, with the exception of asbestos, a known carcinogen. But research on MMMF indicates that the size, shape, and durability of the fiber, rather than the composition, is the significant factor in determining the likelihood of health effects. MMMF, including fibrous glass, slag wool, and rock wool, are used in a variety of consumer and aerospace products. Finer versions of MMMF are particularly good insulators and widespread use of them can be expected in the future. Thus the issue of health risks from fine fibers will be increasingly significant.

Long, thin fibers with diameters of three microns or less are the most likely to be retained in the respiratory tract. There is currently no OSHA standard for MMMF in the air. A Working Group of the International Agency for Research in Cancer has concluded that there is sufficient animal evidence but insufficient human evidence to consider MMMF carcinogenic. The great utility of MMMF makes it likely that they will continue to be widely used, necessitating further research and monitoring of their health effects.

MICROELECTRONICS INDUSTRY

The microelectronics industry may be used as an example in attempting to predict what industries of the future will be like. While it is widely seen as a "clean" industry, with workers in white coveralls guarding against introduction of even a speck of dust, a closer look makes clear that the cleanliness is oriented to protecting the product only, not the workers. Production of semiconductors, a quintessentially modern industry,

involves use of various old-fashioned solvents such as methylene chloride, toluene, and trichloroethylene, toxic gases such as arsine and phosphine, and toxic metals such as arsenic and gallium. Thus, while there is virtually no dust, potentially harmful vapors may be present. An investigation of the work routines of production and maintenance workers reveals numerous severe exposure opportunities and inadequate protective measures. In addition to the indoor risks to workers, the effluents to surrounding neighborhoods, which are often residential, also pose risks; contamination of groundwater resources near microelectronics industry sites is well documented already.

Despite these conditions there has been very little monitoring or epidemiological documentation of the risks of employment in the microelectronics industry. Clearly, worker protection, monitoring, and control mechanisms must be greatly improved, both within the factories and in the areas surrounding microelectronics facilities.

SUPERCONDUCTIVITY AND NON-IONIZING RADIATION

Because of the likely economic benefits of higher temperature superconductivity there will be great pressure to use this developing technology as soon as possible. By the middle of the next century home appliances, transportation, and a multitude of other uses may rely on superconductivity. Resulting strong, stray electromagnetic fields would greatly increase human exposure to non-ionizing radiation.

While all life has developed within weak electromagnetic fields, the

enormous increase in human-made electromagnetic fields in the last 50 years creates levels of exposure for which we have no past experience. Sources of such exposure today include high voltage electric transmission lines, microwave ovens, electronic workstations, and other electronic appliances. Use of electronic devices is likely to increase in the future and the onset of superconductivity would further increase exposure to non-ionizing radiation.

Studies of the health effects in children of exposure to non-ionizing radiation indicate that some fraction of childhood cancer, especially leukemia and lymphoma, may relate to electromagnetic exposure. An occupational study of electric workers showed an increased risk of leukemia, and recent studies indicate possible adverse reproductive effects from daily use over a period of time of video display terminals, a source of non-ionizing radiation. Exposure to non-ionizing radiation possibly may affect the nervous system and susceptibility to chemical exposures. The locus of dysfunction resulting from exposure to non-ionizing radiation may be the cell membrane. The nature of the dysfunction may be an interruption of communication between cells.

The need for further data characterizing electromagnetic fields and the biological mechanisms of non-ionizing radiation is urgent, and a concern for this hazard should be incorporated into land use planning.

CONCLUSION

In the next century we will face new environmental health risks and challenges, but we will also learn more about the environmental causes of diseases and disabilities and improve our ability to detect and treat some of them.

While environmental health catastrophes may arise in the next century that are impossible for us to predict now, there are a number of future environmental health risks which we can reasonably anticipate at this time. We should proceed now to gather the necessary information and take the actions required to deal with these risks. Our agenda should include investigation of the health effects of electromagnetic fields, of potentially toxic compounds in industrial and consumer use, and of new building materials for houses and workplaces. We should institute routine monitoring of our water to ensure its safety and to enable us to evaluate new purification techniques. Monitoring of indoor air and new ventilation engineering techniques to improve indoor quality are also needed. We must develop more sophisticated methodologies for the detection of subtle effects. We need to learn more about the nutritional content of synthetic foods and the health effects of new food processing techniques. We also must develop fertilizers and weed and pest control methods which will taint neither our food nor, through run-off, our water. These and other prudent efforts, undertaken now, will help to ensure good environmental health in the 21st century.